nlgi spokesman

Journal of the National Lubricating Grease Institute

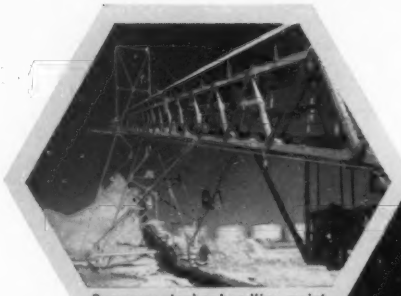
Modern Methods of Lubricant Application

By E. J. GESDORF

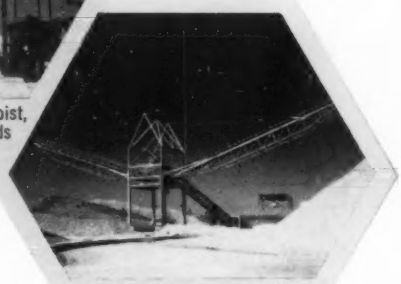
CRC Laboratory Technique for Determining Rust-Preventive Properties of Lubricating Greases

By E. W. ADAMS

"In 14 months...not a single bearing lubrication failure with lithium-base grease!"



Conveyor-stacker handling moist, sticky material which builds up on the rollers.



Ore unloading conveyor rollers handling 200 tons of ore per hour.

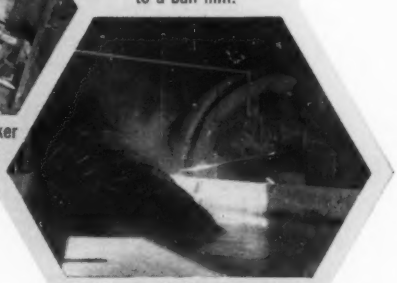
THE PROOF IS IN THE PERFORMANCE...

lithium-base grease does the job...

and does it better!

Pinion gear transmitting power from 600 h.p. motor to a ball mill.

Pan Conveyor handling hot clinker (1600°F), roller bearings in dusty, moist atmosphere.



V.A. Wemco classifier, part of wet grinding system, lower bearing submerged in hot sludge.

Leach tanks handling hot slurry, agitators driven by Falk gear reducing units.

Here's a report of our own experience with lithium-base grease under extreme industrial service conditions. Approximately 95% of the grease used in the plant of AMERICAN LITHIUM CHEMICALS, Inc., our subsidiary at San Antonio, Texas, is lithium-base, one-type grease. In fourteen months operation we have not been able to trace a single cause for bearing failure to the lubricant used. The on-the-spot photos above give graphic evidence of the rugged bearing service requirements in this plant where lithium ores are processed into high-grade lithium hydroxide, itself an important ingredient in lithium-base grease. Performance like this is why grease chemists, manufacturers, marketers and users all attest to the superiority of lithium-base... the *one* grease in place of *many* for efficient and economical operation.

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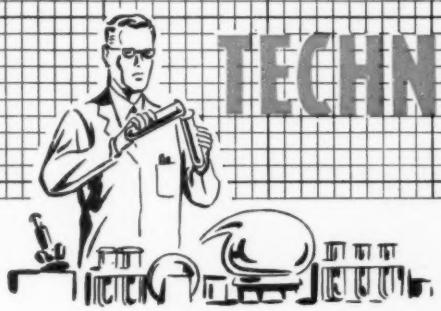

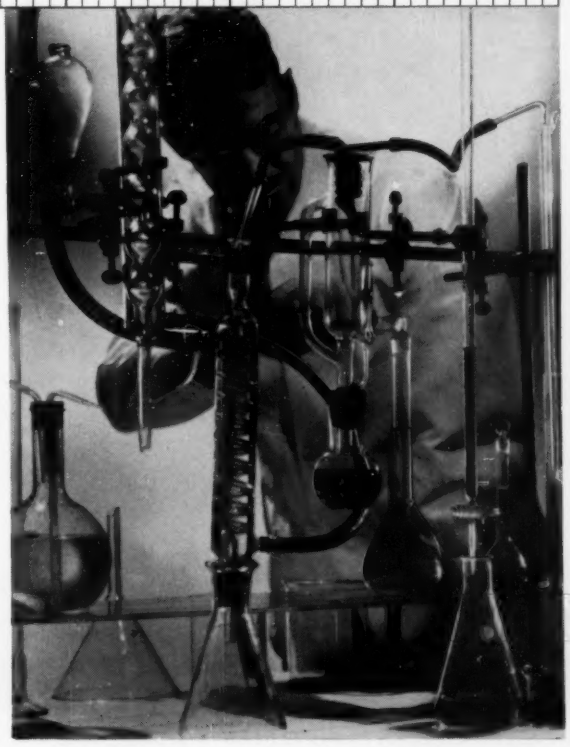

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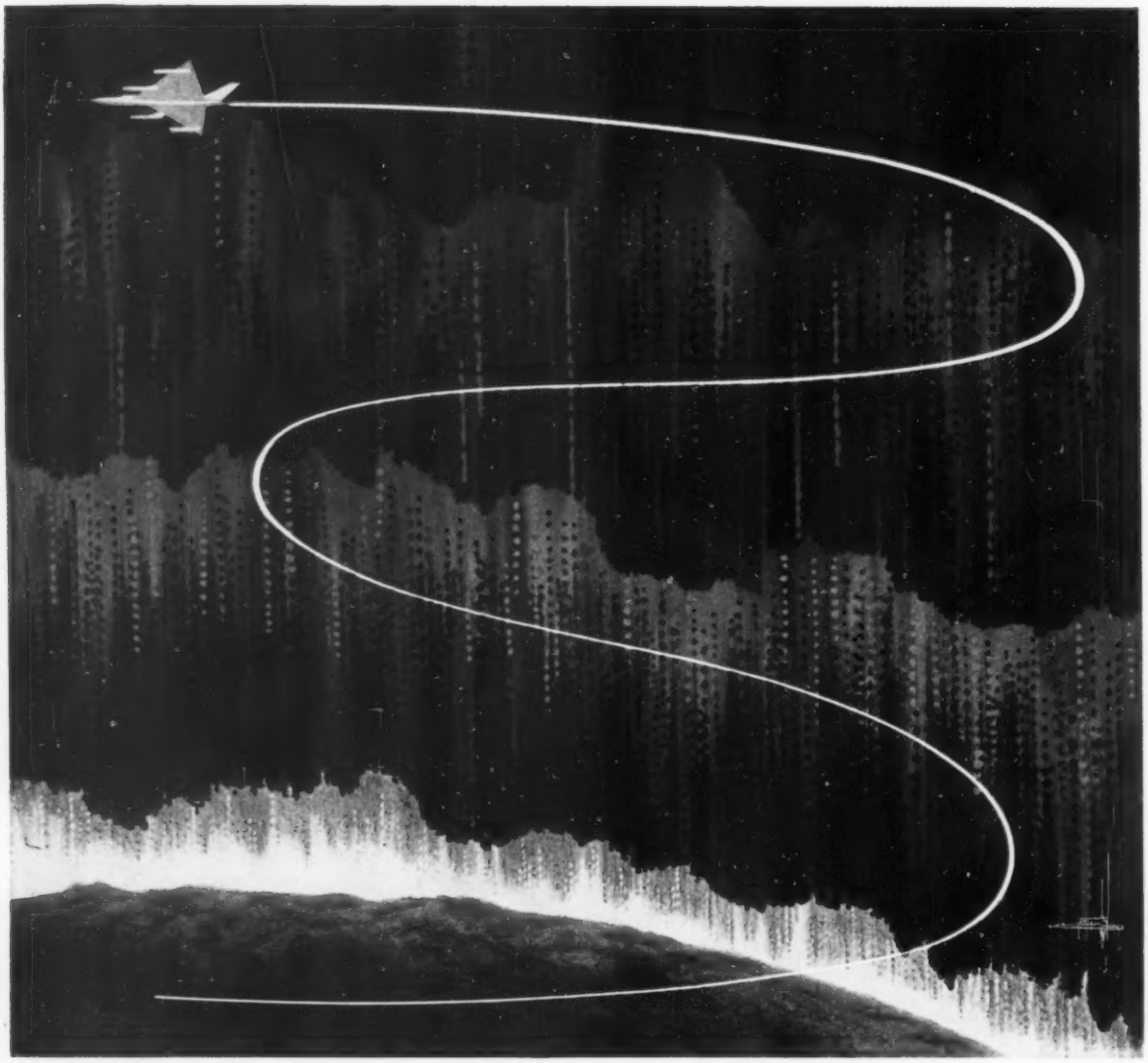

New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

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SHELL

Future Meetings

AUGUST, 1958

10-15 National Congress of Petroleum Retailers, Inc., 12th Annual Session, McAllister Hotel, Miami, Florida.

11-14 SAE, national west coast meeting, Ambassador Hotel, Los Angeles.

SEPTEMBER, 1958

8 NLGI Board of Directors meeting, New York City, location to be announced.

10-12 National Petroleum Association, 56th Annual Convention, Traymore Hotel, Atlantic City, N. J.

24-25 Oil Petroleum Marketers Association Fall Conference and Golf Tournament, Dayton Biltmore Hotel and Walnut Grove Country Club, Dayton, Ohio.

28-30 IOCA Eleventh Annual Meeting, Palmer House Hotel, Chicago, Ill.

OCTOBER, 1958

6-7 Packaging Institute, Petroleum Packaging Committee, Omaha.

13-15 ASLE-ASME Joint Lubrication Conference, Hotel Statler, Los Angeles, Calif.

20-22 SAE National Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.

22-24 SAE National Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.

27-29 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

NOVEMBER, 1958

5-6 SAE, national fuels and lubricants meeting, the Mayo Hotel, Tulsa.

10-12 API annual meeting, Conrad Hilton Hotel, Chicago.

30-Dec. 5 ASME, annual meeting, Statler and Sheraton-McAlpine hotels, New York City.

JANUARY, 1959

25-27 ASLE gear symposium, Hotel Morrison, Chicago.

FEBRUARY, 1959

2-6 ASTM National Meeting, William Penn Hotel, Pittsburgh, Pa.

***MARCH, 1959**

3-5 SAE Passenger Car, Body, and Materials Meeting, Sheraton-Cadillac, Detroit, Mich.

APRIL, 1959

21-23 ASLE Annual Meeting and Exhibit, Hotel Statler, Buffalo, New York.

*Tentative.

MAY, 1959

15-24 International Petroleum Exposition

31-June 6 Fifth World Petroleum Congress.

JUNE, 1959

14-19 SAE Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

OCTOBER, 1959

11-16 ASTM National Meeting, Sheraton-Palace Hotel, San Francisco, Calif.

19-21 ASLE-ASME Joint Lubrication Conference, Sheraton-McAlpin Hotel, New York, N. Y.

26-28 NLGI ANNUAL MEETING, New Orleans, La.

FEBRUARY, 1960

1-5 ASTM National Meeting, Hotel Sherman, Chicago, Ill.

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NLGI PRESIDENT'S PAGE

By R. CUBICCIOTTI, *President*

Needed: New Driver Attitudes

How do we instill in people a feeling of the importance of regular lubrication in the maintenance of their automobiles?

How can we impress upon the average car owner the need of imitating the careful maintenance habits that prevail in successful industrial establishments?

This is the challenge that faces every member of the lubricating grease industry. How well we meet that challenge will determine how much we can increase the sale of our product.

Industry has learned the need for proper maintenance. Each department in a properly run organization is billed for any loss resulting from improper care. The costs of inefficiency are therefore quite apparent to anyone in any given department.

The average owner of an automobile, however, does not operate his vehicle on such a basis that the cost of early slipshod maintenance is either immediately apparent or called automatically and forcefully to his attention.

On the contrary, it might even seem logical for him to assume that by skipping a lubrication job or two he might be saving on upkeep. How can we educate such people to the necessity of regular lubrication for cars no matter how new or old?

Perhaps the answer is contained in a letter I received recently from a friend. Among other things, he related the interesting fact that every one of his four children received periodic check-ups by the family pediatrician from the time the eldest was one month old until the youngest was eight years. The fee for each visit was paid with the hope that nothing serious would be wrong. "And," continued the letter, "probably because the good doctor had a frequent running record of these complicated 'machines', nothing serious ever was."

This is a sensible and wholesome attitude. It also is an attitude we can convey to the average car owner, because, in a sense, the relationship of the lubricating grease industry to automobiles and their drivers is similar to that of the pediatrician to children and their parents.

Every time a car owner pays for a lubricating job he is helping to make certain that nothing serious will go wrong. If he neglects to lubricate his car regularly he is not getting the full value of his investment. What's more, he is guilty of endangering the next driver because improper maintenance makes for unsafe automobiles.

No one knows this better than we members of the lubricating grease industry. And it would be not only a matter of good business but also of good ethics to constantly hammer home this thought to all car owners —through our advertising, our promotional literature, through our customers and other sources of contact with the general public.

And, whatever you do, give the widest possible circulation to a peerless motto that says it all in a nutshell:

"Lubricate for Safety Every 1000 Miles." ■

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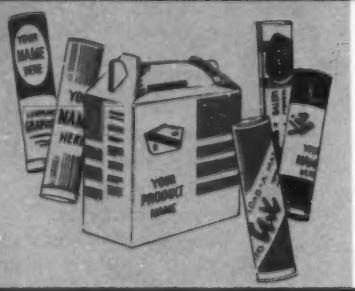

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←UNDER YOUR OWN LABEL...
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←WITH A PRODUCT OF YOUR CHOICE

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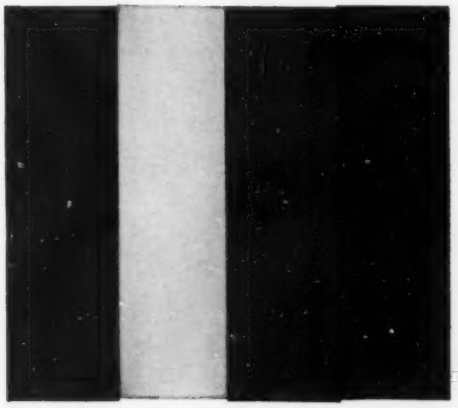

News About NLGI

Fundamental Research Group Will Hold a Concurrent Session at NLGI Annual Meeting

For the fist time in the history of the National Lubricating Grease Institute, the 26th Annual Meeting will offer concurrent sessions. Tentatively scheduled, the regular session will be paralleled by another meeting by the new Technical subcommittee on fundamental research . . . the details may be found in the Technical Comittee column elsewhere in this issue. Another Annual Meeting first has been proposed . . . in order to fully exploit the many aspects of industrial gear lubrication, a joint-session with the American Gear Manufacturers Association is being planned for one of the afternoon gatherings. More details will be published in later issues, as the theme for "Lubricating Grease in Industry" at Chicago, October 27, 28 and 29 is finalized.

New Company Representative

Manton-Gaulin Manufacturing Company, Inc. — has named J. J. Dwyer, industrial sales manager as NLGI Company Representative. Mr. L. H. Rees is NLGI Technical Representative.

Chassis Lubrication Committee

At the May 21 Board of Directors meeting in New Orleans, President R. Cubicciotti formed a new committee to work with other groups in chassis lubrication and oil drains. Mr. H. A. Mayor, Jr. will act as chairman of the Chassis Lubrication Committee.

ASTM Summaries Offered

Through the cooperation of the American Society for Testing Materials, the NLGI SPOKESMAN will begin shortly to bring to its readers a summary of activities by ASTM's committee D-2 on petroleum products and lubricants.

This service to the lubricating grease industry was reviewed by Mr. C. L. Pope, chairman of Tech G, and Mr. P. R. McCarthy, secretary. In the August issue of the journal NLGI will offer a recent summary, and it is hoped that material can then be presented on a semi-annual basis.

ASTM is one of seven technical organizations with which NLGI remains in close liaison.

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NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print $600, second print $400, third and subsequent orders $200 each (non members add $100 to each price bracket).

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VOLUME XXI—Bound volume of the NLGI SPOKESMAN from April, 1957 through March, 1958. Contains 34 articles and features dealing with lubricating greases and gear lubricants . . . $7.00 (NLGI member price) and $10.00 (non-member) plus postage.

BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50, prepaid.

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nlgi spokesman

Volume XXII JULY, 1958 Number 4

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IN THIS ISSUE

Future Meetings 163

President's Page 165

News About NLGI 167

Modern Methods of Lubricant Application 171
E. J. Gesdorf

CRC Laboratory Technique for Determining Rust-Preventive Properties of Lubricating Greases 186
E. W. Adams

Technical Committee Column 194

Patents and Developments 195

Industry News 198

People in the Industry 205

THE COVER

INDUSTRIAL Lubrication as shown in this factory scene on our front cover and as featured in the article "Modern Methods of Lubricant Application," authorized in this issue by E. J. Gesdorf, can help insure the safety of personnel, uninterrupted production, good housekeeping, and a reduction in operating costs. With the trend towards centralized lubrication in many manufacturing situations, the article underscores the progress and notes the adaptability of these processes under specific conditions.

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Number 3 of a series

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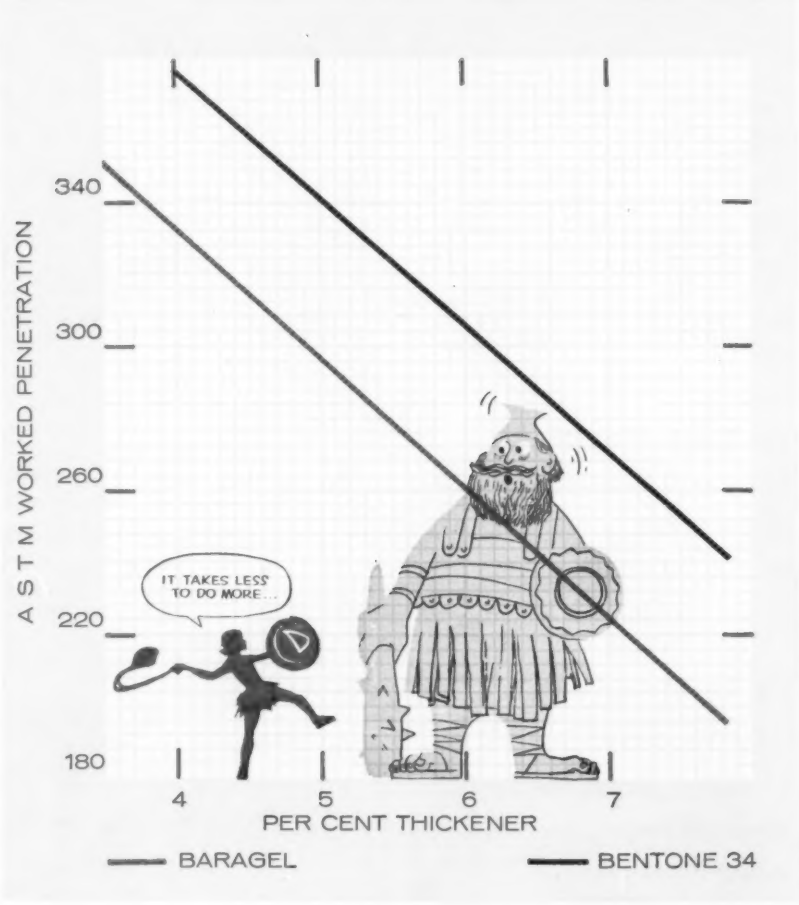

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FUTURE ARTICLES

Shown below are just a few of the papers to be presented in later issues of the NLGI SPOKESMAN . . . several others are pending which promise to be of equal interest to members and friends of the Institute. As always, authors who would like to present a paper to the review committee are invited to do so . . . articles of a technical and of a marketing viewpoint are welcomed.

Rapid Methods of Analysis and Evaluation of Lubricating Greases
CHAMBERLIN, CARTER AND DREHER

Extreme Temperature Range Greases
JORDAN AND ROACH

Summary of Research on Bleeding of Lubricating Greases
FARRINGTON (SYMPOSIUM)

Tensive Stresses on Lubricating Greases Reduce Bleeding
CRIDDLE AND CORTEZ

A New Equation for Calculating Flow of Lubricating Greases
CRIDDLE

The Mixing Efficiency of Grease Kettles
BEERBOWER, FORSTER, KOLFENBACH, AND VESTERDAL

Pyrogenic Silica Thickened Greases
MARSDEN

Grease Bleeding—a Factor in Ball Bearing Performance
BAKER

Sensory Examination of Lubricating Greases
ORR

modern methods of lubricant application

By: E. J. Gesdorf
The Farval Corporation

Introduction

1. In reading over *Lubrication Standards for Industrial Equipment*, prepared separately by several automobile manufacturers in Detroit, I was impressed with the fact that each set of standards started out with a paragraph covering the scope or purpose of the standards. Almost without exception the items mentioned as goals to be achieved were:

1. Safety of Personnel
2. Uninterrupted Production
3. Extended Machinery Life
4. Good Housekeeping

2. All of these items are of considerable importance

Continued, next page

Presented at the NLGI 25th annual meeting in Chicago, October, 1957

modern methods of lubricant application—cont'd

and each has a direct bearing on the subject of this paper—"Modern Methods of Lubricant Application." As a matter of fact, these four points should be considered the keynote of this discussion for if you are interested in good lubrication then you are consciously or unconsciously interested in safety of personnel, uninterrupted production, extended machinery life, and good housekeeping.

3. A fifth item could have easily been added to the goals set up in the lubrication standards for industrial equipment. If a fifth item were permitted, I feel sure that it would be—a reduction in operating costs. In the past, oil, grease and labor were cheap; therefore, little attention was given to methods of applying lubricants. It is an obvious fact that the days of low cost lubricants and low cost labor are gone. As an example, I recently visited a paper mill in Wisconsin and learned that it was costing that particular company, $4.00 in labor to apply each $1 worth of lubricant purchased. The total labor cost for lubrication for the entire plant was $108,700.00. These are significant figures, particularly when you realize that antiquated lubrication application methods are prevalent throughout the mill. Case studies of this type have aroused management's interest in modern methods of application of lubricants.

History

In order to fully understand and appreciate modern lubrication application methods and equipment, some knowledge of the history and development of lubricating methods and devices is essential.

Forty years ago, the only equipment available for applying oil or grease to a bearing was the old oil and grease cups. Typical examples of this type of equipment are shown in Figure 1. As you know, the difficulty with this method of application is that the lubrication of the bearings served is always a feast or famine proposition.

Some of the inventive minds of the day developed an automatic, pressure feeding grease cup in an attempt to solve the problem. Actually, a great number of these devices were introduced, each varying slightly in design, but all similar in principle of operation. An illustration of an automatic pressure feeding grease cup is given in Figure 2. An explanation of how this device functions will, in general, cover all similar devices.

The spring on top of the large piston exerts a constant pressure on the lubricant in the cup. This pressure forces the lubricant around the screw thread on the resistance pin, which is closely fitted to the outlet bore. As grease is discharged to the bearing, the tension of the spring becomes less, but at the same time the screw thread of the resistance pin passes out of the discharge bore, lowering the resistance to flow of the lubricant to the bearing. By this method, resistance to flow is reduced in proportion to the lowered spring

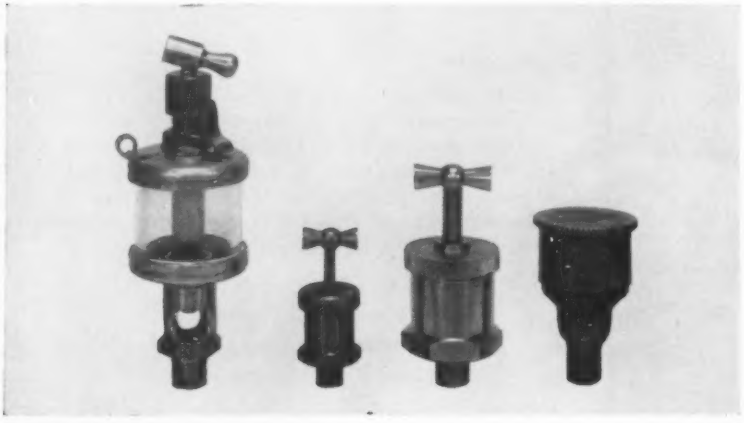


Figure 1

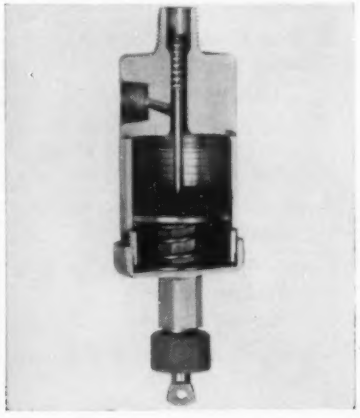


Figure 2

tension and a constant discharge of grease to the bearing is provided.

The constant pressure supplied by the spring, combined with restricted orifice at the outlet, caused many of the greases used to bleed or separate the soap from the oil. When this occurred, the cup would load up with a cake of hard soap preventing further delivery to the bearing.

Most of the pressure feeding grease cups, therefore, required the use of a special lubricant. Special grease was required to insure proper operation of the device, regardless of whether it was suitable for the bearing or not.

Many of these grease cups performed an outstanding job on a few applications, but when they were tried for universal application their limitations were apparent. Several weeks ago I visited a large manufacturing plant in Niagara Falls, where automatic pressure feeding grease cups were being used. These cups were being severely criticized during my visit because the basic weakness of the device had again manifested itself in the form of grease separation which cut off the flow of lubricant to the bearing.

During this period, box oilers, such as shown in Figure 3, came into use. This device was originally designed for engine room lubrication, and it still fits engine room lubrication today better than any other type of lubricator. Actually, there is no one lubricating device or system which is best for all types of lubricant and all types of machine equipment.

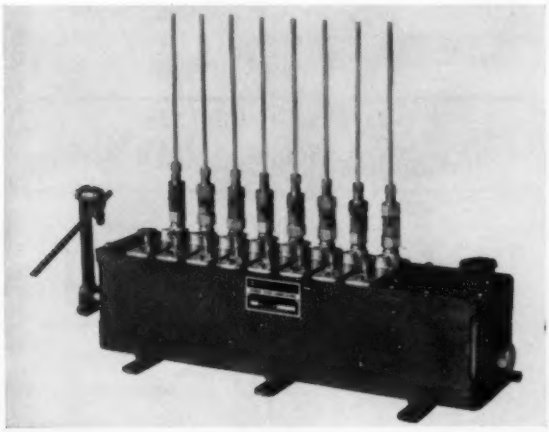


Figure 3

In the past, many box oiler applications were made because there were no other type of mechanical lubricators available. However, today a considerable portion of the box oiler applications have gone over to the centralized system of lubrication. The reason for this is probably because several hundred bearings can be served by one modern, centralized lubricating system very conveniently and very neatly without the necessity of running a bundle of pipe or tubing from one central box.

The first really modern piece of lubricant dispensing equipment developed was the pressure gun and grease fitting, as shown in Figure 4. This equipment was introduced for motor car chassis lubrication in the year 1918. Through the use of pressure guns and fittings, along with the improved quality of lubricants generally, people began to find numerous advantages to high pressure flushing of bearings. This equipment provided a quick and convenient method for delivery of clean grease to a bearing under high pressure, and at the same time flushed out most of the old lubricant. In spite of these obvious advantages, it was not until approximately the year 1922 that the pressure gun and grease fitting came into general use in industry. The savings in lubricant, cleanliness, and better lubrication resulting from the use of the pressure gun and fitting led to the widespread use of this equipment in practically all manufacturing plants.

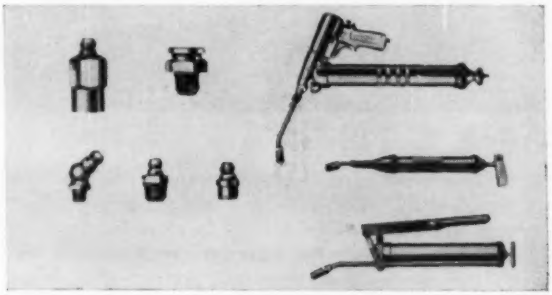


Figure 4

However, with this method, it soon became apparent that many machines had to be shut down in order to lubricate their bearings as very few machines could wait until the noon shutdown or shift change periods for their lubricant. Also, any attempt to lubricate while the machine was operating, involved the risk of injury to the oiler.

The next step in the development of this type of application consisted of grouping the fittings or nipples, at central stations, accessible from the floor, and running individual tubes from each fitting to a bearing. Flexible hose connections were used to connect to movable points of application. This arrangement was the first step in the right direction and is illustrated in Figure 5.

You will note that the greaser or oiler could connect to some 70 or 80 nipples on this press, and lubricate all bearings without having to climb all over the machine, or shut the machine down in order to lubricate. The oiler had to learn through experience, however, about how much lubricant to give each bearing. It was therefore necessary to depend upon a human element, with no accurate control over the quan-

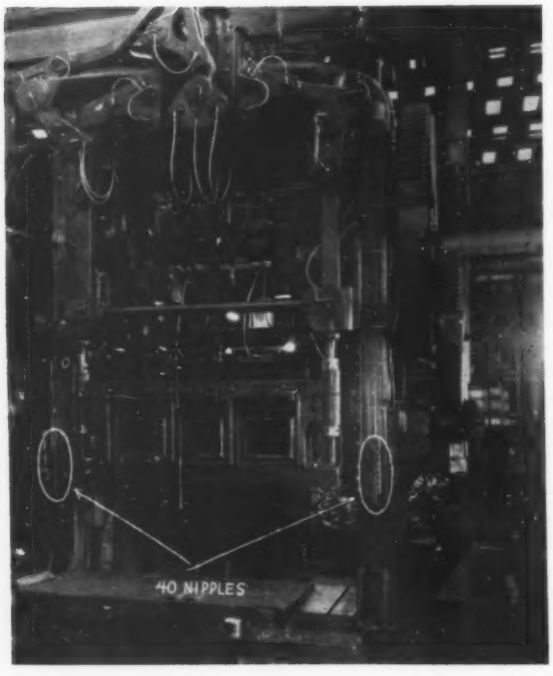


Figure 5

tity of grease delivered to each bearing. The bearings were not visible to the oiler when making the gun connection to the several fittings so some bearings received too much, some too little, and some were missed entirely. In other words, there was no measuring valve for each bearing.

The high pressure gun and grease fitting, as applied to the motor car chassis and industrial machinery, did not provide an accurate control over the amount of lubricant delivered, and there was no assurance that the oiler always connected his gun to every grease fitting. This lack of control and dependence on the human element led to the development of the centralized pressure system of lubrication. As in the case of the grease gun and fitting, the early attempts at centralized systems were first made in the motor car chassis field, and these systems were all of the so-called one shot type.

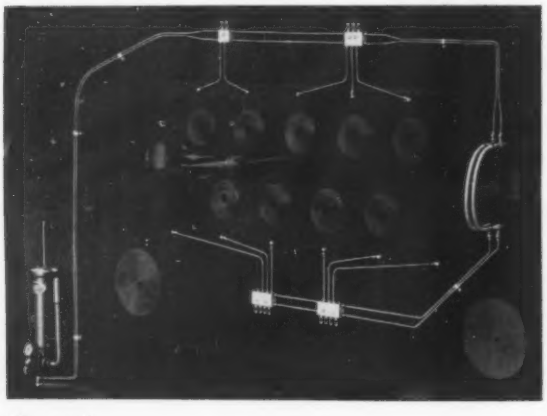


Figure 6

Before proceeding with a discussion on types of centralized lubricating systems, please refer to Figure 6 to get a glimpse of a typical complete system layout with a simple manually operated central pumping unit. You will observe the two main supply lines leading from the hand pump to which all of the adjustable measuring and indicating valves are attached. The measuring valves are located adjacent to the bearings they serve, with short discharge connections, from each valve to the bearing. A large number of manually operating centralized lubricating systems are used in industry today where infrequent applications of lubricant are required.

The first centralized lubrication system installation with which we are familiar is the one that was installed on a Hudson motor car chassis in the year 1922. According to the records, that was the start of the centralized lubrication industry, and from that date, the companies that entered into the manufacture of centralized lubricating systems pursued four distinct principles around which they designed and operated their equipment.

There have been four, and only four principles used in the centralized lubricating system industry. In 1937, we hired a consulting engineer to make a study of possible principles available around which centralized lubricating systems could be made to operate. At the conclusion of his studies the consulting engineer reported to us that there are only four possible principles available for use in centralized lubricating systems and

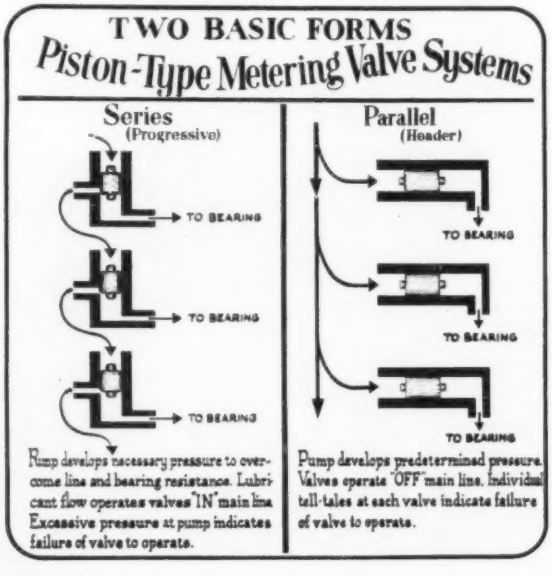

TWO BASIC FORMS
Piston-Type Metering Valve Systems
Series
(Progressive)
TO BEARING
TO BEARING
TO BEARING
Pump develops necessary pressure to overcome line and bearing resistance. Lubricant flow operates valves "IN" main line. Excessive pressure at pump indicates failure of valve to operate.
Parallel
(Header)
TO BEARING
TO BEARING
TO BEARING
Pump develops predetermined pressure. Valves operate "OFF" main line. Individual tell-tales at each valve indicate failure of valve to operate.

Figure 7

that is all there ever will be. This statement by the consulting engineer was not fully accepted, but here it is 20 years later and no one has developed a fifth principle around which they can design a centralized lubricating system.

There are some who prefer to classify all centralized lubricating systems in two groups, under the headings of Series Type and Parallel Type, as shown in Figure 7. In using this method of comparison, basic system operating principles as well as measuring valve design features are ignored. We believe that a detailed study of the four basic principles in general use in the centralized lubrication industry today, along with a close examination of the type of equipment being offered, has the greatest value for the student of centralized lubrication. The following section of this discussion, therefore, will be devoted to the four basic principles.

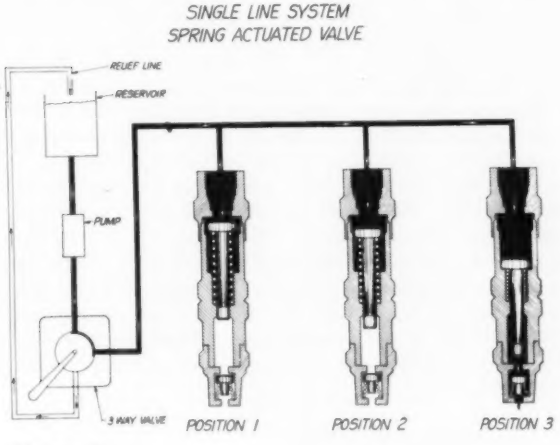


Figure 8

The Four Basic Principles

Figure 8 illustrates a single line system, employing spring return measuring valves. Some of the systems of more modern design, using this principle of operation, have included indication and adjustment at each measuring valve. The main system elements consist of a reservoir, a pump, a three-way valve, and a series of spring-operated measuring valves, which are connected to a common supply line. If the pump is operated with the three-way valve in the position shown, a pressure is developed in the main supply line which becomes effective on the top of the main piston in the measuring valve, causing it to move in a downward direction, forcing the lubricant ahead of the piston into the bearing. Pumping is continued until all measuring valves have discharged, which is noted by the operation of a poppet type indicator stem, or a pressure gauge.

To recycle the system it is necessary to turn the hand lever of the three-way valve 90° thereby connecting the main supply line to the relief line to exhaust pressure that was developed in the system. When the main line pressure drops to a lower value than the energy force of the compression spring in the measuring valve, the spring returns the valve piston to its original position. Reloading of the measuring valve takes place when the valve piston reaches the enlarged section of the piston bore.

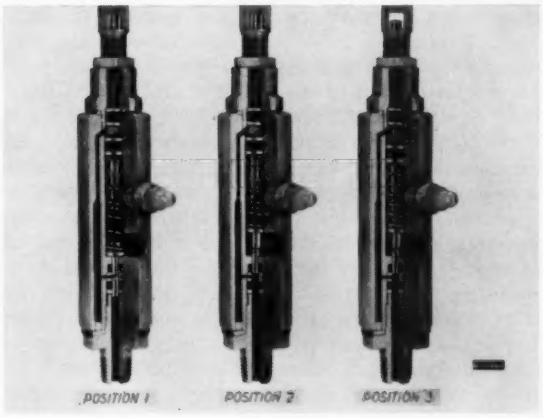


Figure 9

In this type system, the pistons are moved hydraulically in one direction and by spring force in the opposite direction. A typical sectional assembly view of a single line spring-operated measuring valve is shown in Figure 9.

Figure 10 illustrates a non-reversing progressive system which uses the divisional principle to divide the delivery from the pump into several bearing outlets. The measuring valve is progressive and non-adjustable with indication usually at the pump. The main system elements consist of a reservoir, a pump, a main supply line, and the measuring valve manifold. If the pump is put in operation, lubricant is taken from the reservoir and passed through the main supply line to the meas-

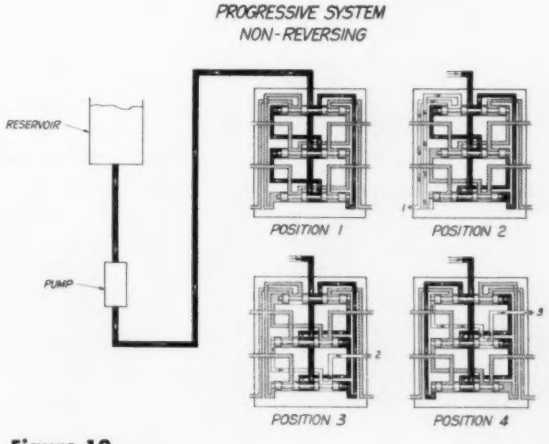


Figure 10

uring valves. By studying position 1 of the diagram, you will note the measuring valve sections are connected together with a common central pressure port. The center section of the piston of the bottom measuring valve permits a flow of pressure to the left end of the piston in the center measuring valve to hold the piston in the right end of its bore. Likewise, the center section of the middle measuring valve permits the flow of pressure to the left end of the piston in the top measuring valve to hold the piston in the right end of its bore. The center section of the piston in the top measuring valve permits pressure to flow through the valve porting to the extreme right end of the piston in the lower measuring valve, causing the piston to move to the left, displacing or pushing a quantity of grease in the left end of the bore through valve porting out to a bearing at outlet 1, shown in position 2 of the diagram.

As the bottom piston moved from right to left, you will note that the center section of the piston changed the porting to permit pressure to flow to the right end of the center piston. This causes the center piston to move to the left end of its bore, displacing or pushing a quantity of lubricant in the left end of the bore through valve porting out to a bearing at outlet 2, as shown in position 3 of the diagram.

In moving from right to left, the center piston changes the porting through its center section to permit pressure to flow to the right end of the top piston. This causes the top piston to move to the left end of its bore, displacing or pushing the quantity of lubricant in the left end of the bore through valve porting out to a bearing at outlet 3, as shown in position 4 of the diagram. The top piston, in moving from right to left, causes a changing of the porting at its center section to permit a flow of pressure to the left end of the lower piston. This causes the lower piston to move to the right end of its bore, displacing the quantity of lubricant in the right end of the bore, to a bearing. By studying the diagram and following the foregoing sequence, you will soon find that this is a continuous cycling mechanism which will continue to operate as long as there is flow from the pump.

A typical, progressive, non-reversing metering valve manifold with one metering valve section cut away is shown in Figure 11.

Figure 12 illustrates a loop-system, which operates on the principle of reversible flow in the main supply line. The measuring valves are progressive and non-adjustable, with indication at the end of the loop.

The main system elements consist of a reservoir, a pump, a four-way valve, a main supply line, and a series of measuring valves inserted in the main supply line. If the pump is operating with the four-way valve in the position shown, the lubricant is taken from the reservoir and directed into the main line loop, discharging from the four-way valve at the left and entering the first measuring valve, as shown in position 1. After moving a check piston and two pilot pistons, lubricant is permitted to flow into the main cylinder, forcing the measuring piston to the right, and displacing the lubricant in the right end of the cylinder to a bearing. This is shown in position 2. At the end of its travel the measuring valve piston uncovers a bypass port to allow the flow of lubricant from the pump to pass around the measuring valve piston and through an outlet check valve as shown in position 3. The lubricant then moves on to the next measuring valve in the circuit, where the valve operation sequence is repeated.

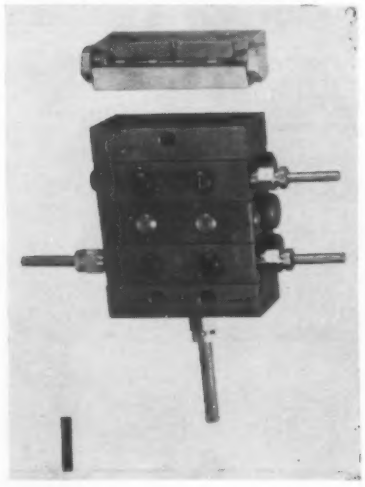


Figure 11

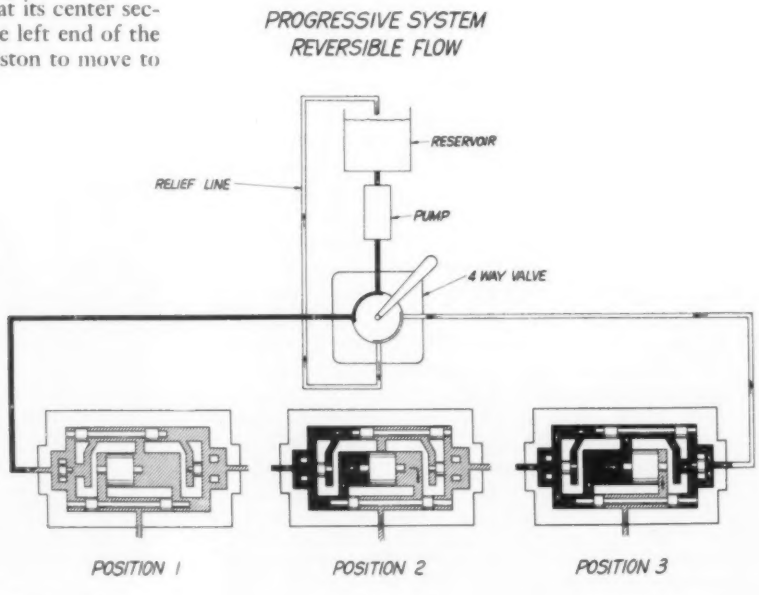


Figure 12

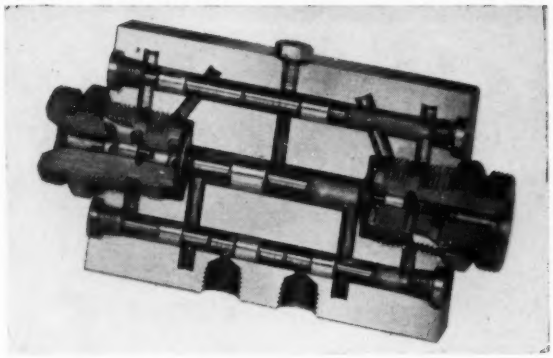


Figure 13

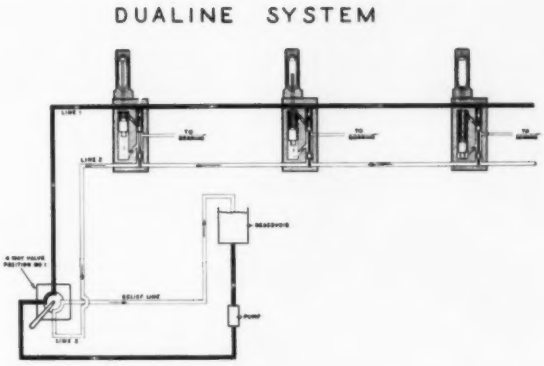


Figure 14

Figure 15

Pumping is continued until all measuring valves have operated and until a flow of lubricant reaches the central pumping unit to operate an indicator, thus completing one lubricating cycle.

To re-cycle the system, the hand lever on the four-way valve is shifted 90° to change the porting of the four-way valve to permit the flow of lubricant from the pump to be directed into the main supply line loop, discharging from the four-way valve at the right and entering the first measuring valve on the right end of the circuit. In effect, shifting the four-way valve reverses the flow of lubricant in the main supply loop.

The measuring valves are again operated and the sequence of valve operation is as described in the foregoing except that the main line flow is in the opposite direction.

A cut-away section of a typical progressive reversible flow metering valve is shown in Figure 13.

Figure 14 illustrates a system which uses the dualine principle with alternating pressure applications in the two main supply lines. The measuring valves operate independently and offer indication and adjustment for each bearing.

The main system elements consist of a reservoir, a pump, a four-way valve, and dual main line piping to which all measuring valves are attached.

If the pump is operated with the four-way valve in the position shown, lubricant is taken from the reservoir and directed into main supply line 1. As the pressure increases, it becomes effective on the top side of the pilot piston in the measuring valve, causing it to move in a downward direction. After a certain amount of travel, an angle port is opened permitting lubricant to flow into the main measuring cylinder, forcing the main piston in a downward direction. As the main piston moves downward, lubricant in the lower portion of the cylinder is forced ahead of the piston through a second angle port and out the discharge port to a bearing. Pumping is continued until all measuring valves have operated.

To recycle the system, the hand lever of the four-way valve is shifted 90° which relieves the pressure in line 1 back to the reservoir and ports the pump to line 2. As pressure is developed in line 2, the measuring valve operation sequence described in the foregoing is repeated but with the valve pistons moving in the opposite direction. Indicator stems attached to the main pistons of the measuring valves provide a means for periodic inspection of the valve operation. Valve discharge adjustment is accomplished with two flat adjusting screws in the packing gland which control main piston travel.

A typical cut-away valve section of a Dualine metering valve is shown in Figure 15.

In going over the four basic principles around which modern centralized lubricating systems are designed, we have purposely avoided a discussion of the advantages and disadvantages of the various principles as this phase is not within the scope of this paper. It is felt, however, that any competent engineer, sitting down at his desk with the diagrams and sectional assembly metering valve illustrations of the four principles involved could very easily evaluate the merits of the

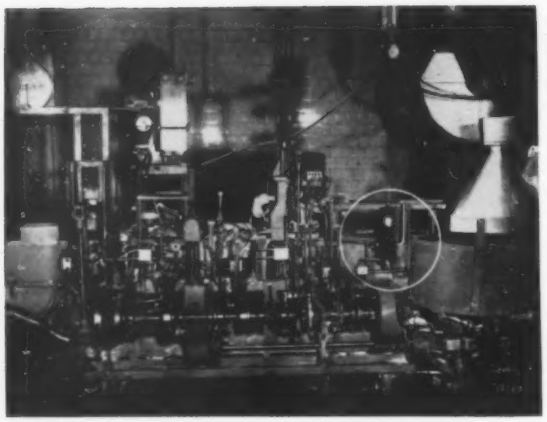


Figure 16

various equipment described. Above all other considerations, simplicity of principle and design in a lubricating system are foremost in importance.

Figure 16 illustrates an extremely complicated machine that is served by a centralized lubricating system. This is an Anderson sealer which is used in the food packaging industry for closing and sealing cereal boxes, etc. You can appreciate that lubricating this machine by hand would be a cumbersome and time-consuming job. Furthermore, the machine would have to be taken out of production for lubrication, and it would be doubtful whether the oiler would find and lubricate every bearing.

With the compact centralized lubricating system shown on this machine, the entire machine can be lubricated in less than one minute without loss of production and with all bearings receiving the exact amount of lubricant required and none of the bearings being skipped. The centralized lubricating system business has progressed to a point where the system idea has gained universal acceptance.

SIMPLE HYDRAULIC SYSTEM
WITH 4-WAY VALVE CONTROL

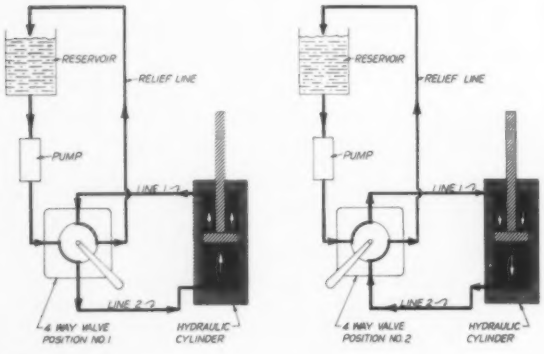


Figure 17

Understanding the Basic Operating Principle

A short time ago I gave a talk to the industrial lubricating committee of General Motors at their Technical center in Detroit. The subject of my talk was "How the user can get the most out of centralized lubricating systems." In this talk, I pointed out the three natural enemies of all types of centralized lubricating systems. They are as follows:

1. Improper system layout and installation.
2. Foreign material in the lubricant.
3. Lack of understanding of the basic operating principles of the system by the system operators and maintenance personnel.

I wish time were sufficient to discuss each of these system enemies and show you how they can be successfully combated or subdued. I will, however, take the time to show you how the No. 3 enemy, "Lack of understanding of the basic operating principles of the system," can be eliminated. By starting with a fundamental principle and developing it into a lubricating system, I believe that you will agree that you have a much better understanding of how a centralized system operates, especially after studying the diagrams.

Figure 17 illustrates a simple hydraulic system with a four-way valve control. This system has universal application in industry for lifting weights, closing vice jaws, moving machine tables back and forth and for numerous other jobs that can be cited. As a matter of fact, if a hydraulic engineer has a work job or a motion job to perform, he usually employs this principle. This simple system will operate on air, water, oil or grease.

The main system elements consist of a reservoir, a pump, a four-way valve, and a hydraulic cylinder. The four-way valve undoubtedly got its name from the fact that it has four line connections—a pump line, two cylinder lines, and a relief line.

FARVAL LUBRICATING SYSTEM
USING SIMPLE HYDRAULIC PRINCIPLES

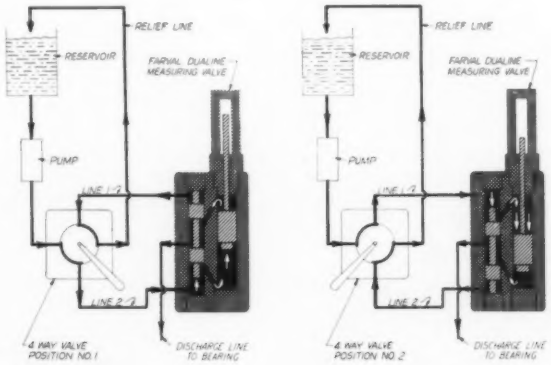


Figure 18

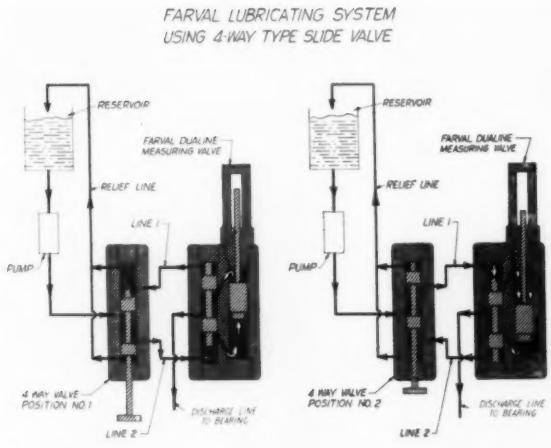


Figure 19

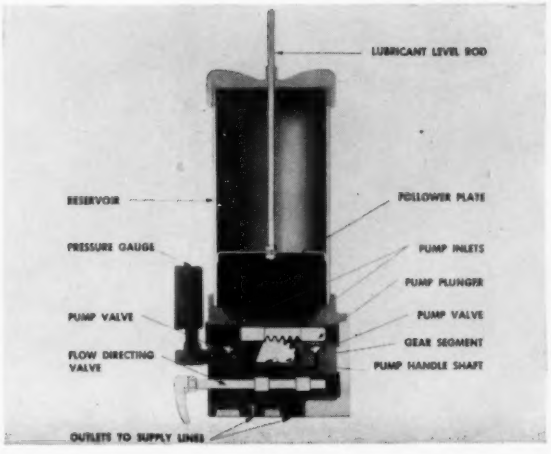


Figure 20

If the pump is operated with the four-way valve in position 1, lubricant is taken from the reservoir and directed into cylinder line 2. As the pressure increases it becomes effective on the bottom side of the piston in the hydraulic cylinder causing it to move in an upward direction doing the work attached to the piston rod. You will note in studying the diagram that while cylinder line 2 is ported to pressure, cylinder line 1 is ported to relief or to the reservoir. This is a condition that must be established for provision must be made to exhaust the lubricant from the top side of the cylinder as the piston moves in an upward direction.

After the piston has reached the end of its travel and it is necessary to return it to its original position, the four-way valve is shifted 90° as shown in position 2 of the diagram to port cylinder line 1 to the pump and port cylinder line 2 to relief. If the pump is operated, pressure is developed in line 1 and on the top side of the piston in the cylinder causing it to move in a downward direction. The lubricant under the piston is forced ahead of the piston into line 2 and back to the reservoir.

This is purely a work or motion system. It does not consume lubricant, it merely uses the lubricant over and over to transmit power developed by the pump.

Figure 18 demonstrates how the simple work system can be converted to a simple lubricating system to measure lubricant and discharge it to a bearing. You will note that the same system elements are present as shown in Figure 17 with the exception that the hydraulic cylinder has been replaced with a measuring valve. Actually, if you stop to think about it, the only specific change is the addition of the pilot piston in the measuring valve. The pilot piston, however, plays an important part in converting the simple work system into a simple lubricating system which you will soon see.

If the pump is operated with the four-way valve as shown in position 1 of the diagram, lubricant is taken out of the reservoir and directed into line 2. As the pressure increases, it becomes effective on the bottom end of the pilot piston causing it to move in an upward direction. After a certain amount of travel, an angle port is opened permitting the lubricant to flow to the bottom end of the measuring cylinder forcing the main measuring piston upward. As the main piston moves, the lubricant in the top end of the cylinder (from previous operation) is forced ahead of the piston through a second angle port and out of the discharge port to a bearing.

After the main piston has completed its travel, no more lubricant can reach the bearing until the system

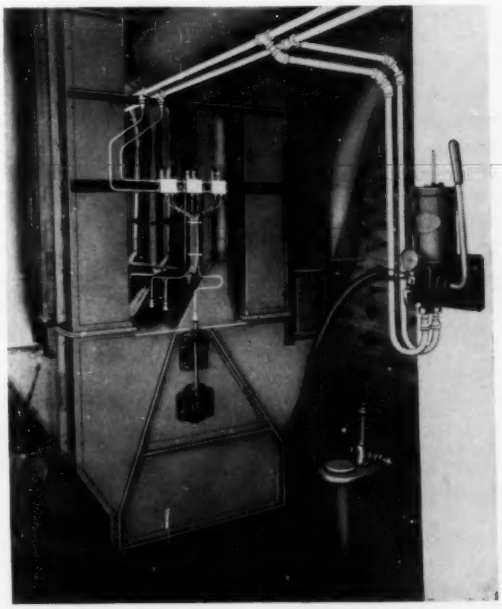


Figure 21

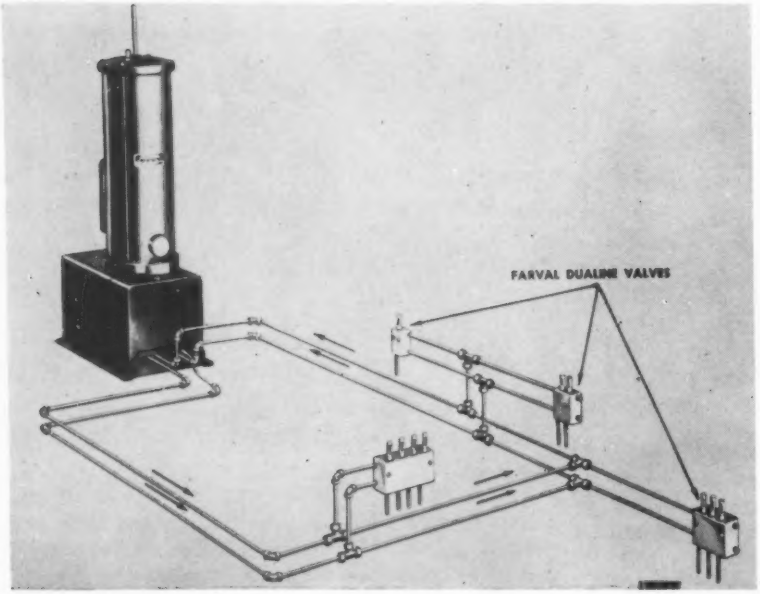


Figure 22

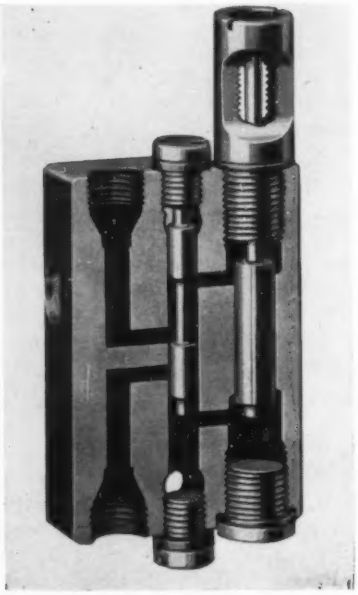


Figure 23

has recycled, and this is done by moving the hand lever of the four-way valve 90° to position 2 as shown.

If the pump is operated, lubricant is directed into line 1 and pressure moves the pilot piston in a downward direction until an angle port is opened. Pressure is then permitted to flow into the main cylinder forcing the main piston in a downward direction discharging the lubricant under the piston through a second angle port, out the discharge port to the bearing. At the end of the main piston travel, the flow of lubricant to the bearing is shut off.

As you see, this is a double acting measuring valve, which discharges lubricant to a bearing on the upstroke as well as the down-stroke. Visual indication is offered by a positive indicator attached to the main piston, and discharge adjustment is accomplished by control of main piston travel.

To continue with the development of this lubricating system, please refer to Figure 19, which illustrates the use of a push-pull type four-way valve. The only change that you will note is that the rotary type four-way valve has been replaced with the push-pull type four-way valve. We continue to use the same system elements of a reservoir, a pump, a four-way valve and a measuring valve—no change in operating principle.

With the slide valve in position 1 as shown in the diagram, you will note the required condition of having line 2 under pressure while line 1 is open to relief. There will be no need to go through the measuring valve operating sequence since you already understand this.

If the slide valve is pushed into position 2 as shown, line 1 is subjected to pressure from the pump while line 2 is open to relief—the condition necessary to operate the measuring valve a second time.

The reason for showing the slide type four-way valve is that this is the four-way valve design that is in common use in lubricating systems in industry.

We have talked about reservoirs, pumps, four-way valves, etc. Figure 20 shows a sectional view of a typical manually operated hand pump and illustrates how several of the system elements already discussed are designed into one unit. This is done to bring about neatness and to provide a compact unit eliminating inter-connecting pipe lines.

Various Types of Systems—Manual, Automatic, Etc.

Figure 21 again shows a complete manual system installation with some variations of what you saw previously. I believe that now you are beginning to appreciate the tremendous flexibility in centralized system layout to satisfy specific conditions. Here large diameter main line piping is used because the pumping distance is great and it is desirable to provide a system that will operate at normal pressures under the most adverse conditions. Manual systems are used where infrequent lubrication is required such as once every four hours and where the attendant can be depended upon to perform the operation.

Where conditions demand the renewal of lubricant at frequent intervals, the power driven automatic system with time clock control may be employed as shown in Figure 22. An electric time clock starts the motor driven pumping unit, and after all of the measuring valves have operated, an additional pressure is

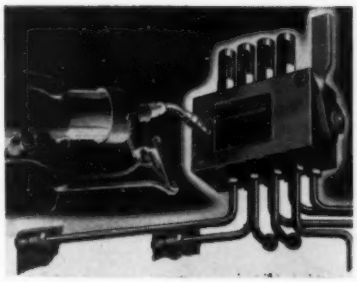


Figure 24

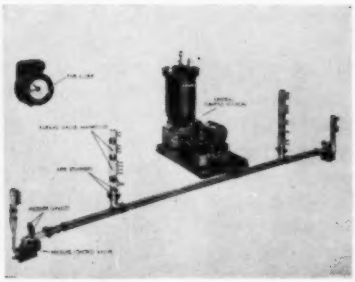


Figure 25

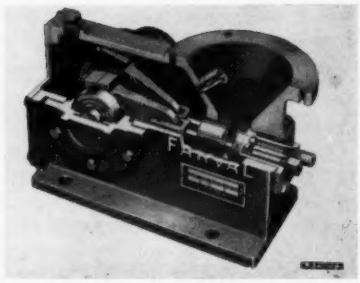


Figure 26

built up at the end of the system to operate the flow reversing valve and attached electrical switch to shut off the pump motor thus ending one complete lubricating cycle. The frequency of the lubricating cycles are controlled by the time clock and can be set to repeat as often as desired.

In contrast to the heavy duty units, there are small systems using measuring valves of the type shown in Figure 23 which are applied to smaller machine equipment. You will note this small valve employs the same positive displacement principle of measurement as the large valve, is fully adjustable for quantity, and contains but two moving parts. This unit will distribute either oil or grease and is being employed for lubrication of printing machinery, packaging machinery, wire forming machines, textile machines, glass and can machinery, and on many other types of small machine equipment.

The complete line of centralized equipment also includes measuring valve block as shown in Figure 24. This unit is designed for use with any conventional type portable grease gun to serve a limited number of bearings where the complete system with its permanent central pumping unit would not be justified. From two to twelve bearings can be served from one block, and the unit will handle either oil or grease. The multiple valve block offers the advantage of a measured amount of lubricant for each bearing, positive indication, and a reduction in the number of gun connections required. This unit is being widely used for the lubrication of the smaller, inclinable and single crank presses and for lubricating isolated groups of bearings on many of the larger tools and equipment.

The large heavy duty automatic central pumping unit shown in Figure 25 will hold as much as 550 pounds of lubricant and was designed primarily for use on roll necks in the steel industry. However, heavy duty, automatic systems are now being used extensively for the lubrication of rubber mills, sugar mills, forging machines, blast furnace tops, rock crushers and group installations of metal stamping presses, etc. This type of system provides a positive, dependable method of lubricating a large number of bearings over a wide area from one central point. It is common practice to serve several hundred bearings by this method, and in some instances, as many as 2,000 bearings are lubricated from one central point.

A short time ago I read a technical paper in which it stated that the trend in industry is toward smaller systems, and an example was cited of six finish stands in a hot strip mill each having an individual system. The author of that particular paper may have been speaking of a specific application, or the lubrication equipment he had in mind probably could not be satisfactorily applied to a large number of bearings over a wide area. Anyone can recognize the disadvantage in a separate system on each of six finish stands as this is a complete reversal of the centralized idea and gets back to the old fashioned method of lubrication by filling, servicing and maintaining numerous pieces of equipment individually. There is no trend towards smaller systems as modern centralized lubricating equipment with adjustable time cycle and adjustable metering valves makes it possible to serve a great num-

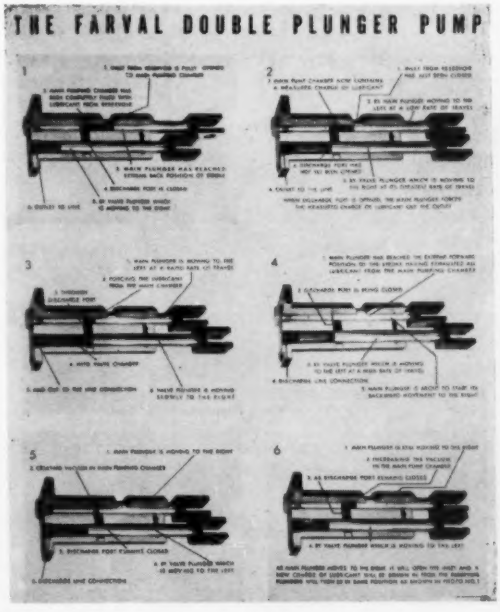


Figure 27

ber of bearings scattered over a considerable distance from one central point.

Of particular interest is the double plunger pump principle which is used in heavy duty automatic pumping units and which is illustrated in Figures 26 and 27. This pump design eliminates the check valve which is usually required in a single plunger pump by replacing it with a positively driven slide piston. The pump pistons and cylinder are made of nitroloy steel which gives excellent resistance to wear. Actually, we have had pumps run as long as 20 years without requiring replacement parts.

Electrical Controls

The electrical timing of an automatic lubricating system is an interesting study. The basic idea employed is shown in Figure 28. To get the idea across, a simple analogy is drawn between a home lighting circuit and a lubricating system tuning circuit. The diagram on the left shows a second floor light being controlled by two single-pole, double-throw switches—one located on the first floor, the other on the second floor. If a person came home late at night and needed the second floor hall light, the first floor switch would be operated. This would move the switch contact into position to allow power to flow from L1 through two switches and through the light bulb into L2. The circuit is complete, and the light will burn.

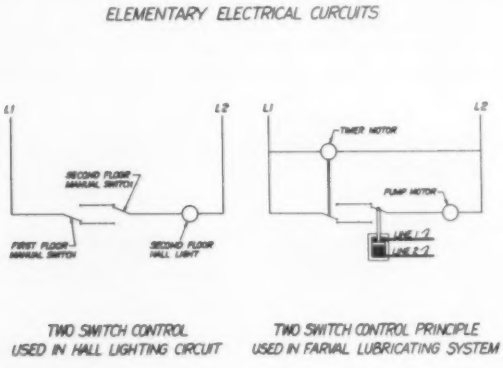


Figure 28

Upon reaching the second floor, the use of the light can be discontinued by operating the second floor switch. This moves the second floor switch contact to a position which interrupts the flow of power to the light bulb and the light bulb goes out.

By moving over to the right hand section of the diagram, you will see that instead of a light bulb, a pump motor is being controlled by two single-pole, double-throw switches. One is actuated by an electric timer and the other by a reversing valve on the pumping unit. The timer motor is directly across the power lines, and therefore operates all the time. At the selected interval, the timer trips the single-pole, double-throw switch to start the pump motor. Lubricant is pumped out supply line 1, and after all of the measuring valves have operated, an additional pressure is built up at the end of the line to operate the reversing valve and attached electrical switch to end the lubricating cycle. The timer is adjustable and can be set to start the lubricating cycle at any desired interval.

A timer has one function to perform, and that is to start the pump motor. The starting interval can be adjusted by changing the active pin combination in the timer dial. If for example the timer dial has 20 pins and the dial makes one revolution per hour, the spacing between the pins is three minutes. If all pins are in the dial, the timer will start the system every three minutes. If every other pin were removed, the system starting interval would then be on six minute intervals, etc. For longer timing intervals, timer dials making one revolution in two hours, four hours, six hours, twelve hours or twenty-four hours are available.

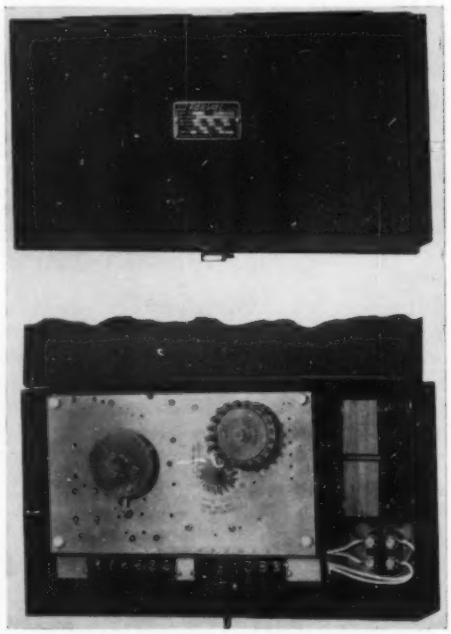


Figure 30

Figure 30 shows a typical system timer with an additional feature—a warning timer. The warning timer is an extremely desirable feature as it will give protection against a broken main supply line, air in the reservoir, empty reservoir, failure of the system to reverse, excessive pressure in the system, etc.

The timer dial on the right regulates the operating frequency of the system. The dial on the left controls the warning device. Actually, the warning timer is wired in parallel with the pump motor. If for any of the reasons mentioned in the foregoing the pump mo-

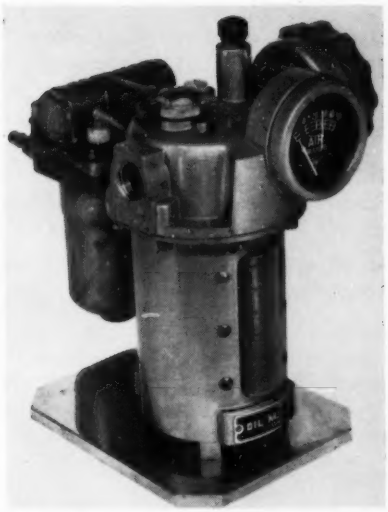


Figure 31

tor runs longer than is normally necessary, the alarm will go off indicating trouble.

Mist or Fog Lubrication

Oil mist lubricators, such as shown in figure 31 have been designed for supplying light and medium oils automatically in the form of an oil fog to the bearings of small high speed machine tools. A typical application would be the high speed anti-friction bearings used in grinding machine spindles. Ideal lubrication of these spindles is obtained when the bearings receive just enough oil to wet the surfaces. Excess oil has a tendency to retard the speed and generate heat, due to a churning action.

This lubricator is available in the form of a system which is capable of serving a limited number of bearings from a central unit. Oil is injected into a stream of low pressure air which breaks it up into a fine mist. A filter to provide clean, dry air, and a regulator to control the air, are included. Oil consumption can be limited to a few drops per hour.

Excessive moisture in the compressed air system can cause trouble with this type of lubricator. One of the limiting factors in mist or fog lubrication is that the lubricators can rarely handle oils having a viscosity above 1000 seconds at 100° F.

Many successful oil fog installations have been made during the past five years. The present day oil fog lubricators have been designed to produce a mist that is composed of a particle size, two to five (2 to 5) microns in diameter. As you know, one micron is 1/1000 part of one millimeter.

Circulating Oil Systems

Where oil lubrication is required under controlled pressure and in sufficient volume to flood the bearings continually, a circulating oil system, such as shown in Figure 32, is usually employed. The chief field of application for this type of lubricating system has been in steel rolling mills, paper mills and power plants, on drive gearing, motors, dynamos, turbines and engines.

There are two types of circulating oil systems in use, the gravity feed and the pressure, or forced feed systems. In a gravity feed system, two reservoirs are employed, one above the highest point to be lubricated, and one below the level of the lowest point to be lubricated. Oil feeds by gravity to the bearings and then drains to the lower reservoir, after which it is returned through filters to the upper reservoir by means of a pump. The pressure system involves the use of a pump to force the oil to the bearings, which returns to tanks by gravity. Cooling is usually employed on

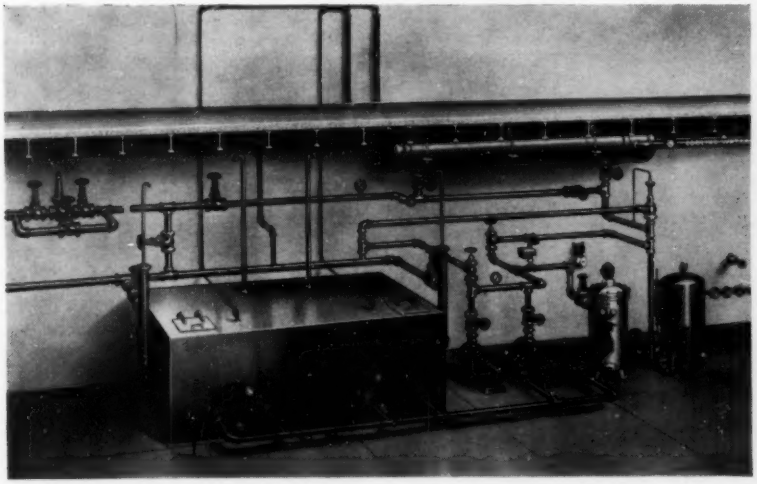


Figure 32

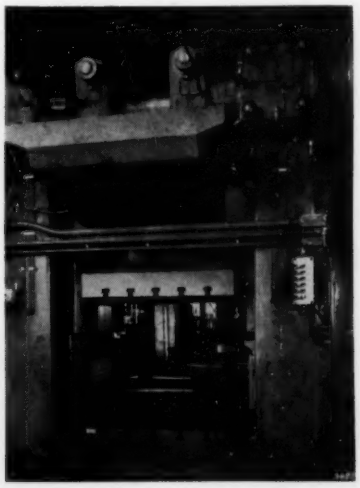


Figure 33

the return lines. The pressure is controlled by the use of pressure relief valves or orifices. Forced feed pumps are used where large volumes of oil are to be handled. The circulating oil system illustrated is one of modern design in popular use in industry today. Systems of this type are entrusted with the lubrication of bearing installations costing hundreds of thousands of dollars.

During the past two or three years there has been a gradual movement to circulating oil systems by the stamping press industry. An illustration of this type of installation is shown in Figure 33. This evolution was brought about by a strong desire for improved lubrication, better housekeeping, elimination of fire hazards. Incidentally, the disastrous General Motors fire in their automatic transmission plant a few years ago set many minds to thinking about improved lubrication methods.

Subsequently, a new approach to a circulating oil system was introduced to the press industry. High volume oil pumps are applied to conventional centralized lubricating systems to cause them to discharge oil to the bearings several times per minute. Bearings are flooded with oil and drain-back systems are used to return the excess lubricant to a settling tank from which it is again pumped and filtered and returned to the bearings. The precise equipment used in a centralized circulating oil system is shown in Figure 34.

The relatively low cost of the new type circulating oil systems for presses place them within reach of all press users and builders. The demand for this type of system can only be applied to machines that have been properly designed to accommodate the installation.

Some of the outstanding features of centralized circulating oil systems are as follows:

1. All bearings are continually flushed with clean lubricant.
2. Warning protection is offered that will shut the press down in the event of an excessively high pressure build-up, or in the event of a complete loss of pressure in the system. This protection covers clogged bearings or clogged measuring valves, and broken discharge lines or broken supply lines.
3. Indication is provided on every metering valve to quickly locate difficulty should trouble occur.
4. Dual filters permit changing a filter without shutting down the machine.

It is my opinion that you will see a great many more centralized circulating oil systems as time goes on, and installations of this type of system will spread to other machine applications where a small inexpensive circulating oil system would be desirable.

Spray Lubrication of Open Gears

It is true that open gears are gradually passing out of the industrial picture although there are still thousands of open gear installations that will be in continued use for many years to come. Open gears are also being used on new equipment being manufactured today, such as presses, ball mills, kilns, paper mills, sugar mills, etc. This practice prevails because of the prohibitive costs for enclosing the gears.

In the past, these gears were lubricated by swabbing, brushing, pouring, dipping, and dripping. All of these methods of application have had disadvantages in throw-off, drippage, lack of uniform distribution, excessive consumption, and expenditure beyond an economical standard in cleanup and disposal labor.

To combat this problem, manufacturers of centralized lubricating systems have developed automatic and semi-automatic gear spray systems, such as are shown in Figures 35 and 36. These systems have received broad acceptance in the cement, paper and steel in-

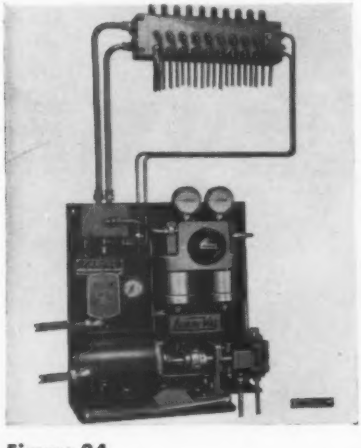


Figure 34

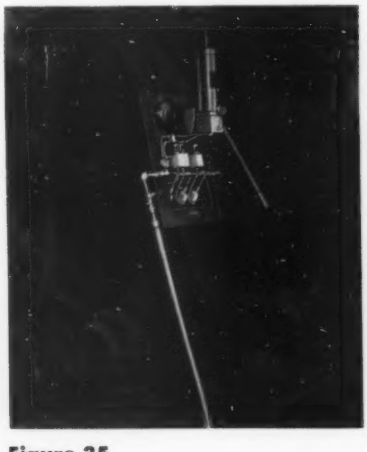


Figure 35

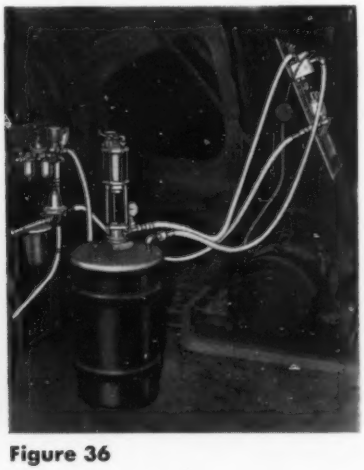


Figure 36

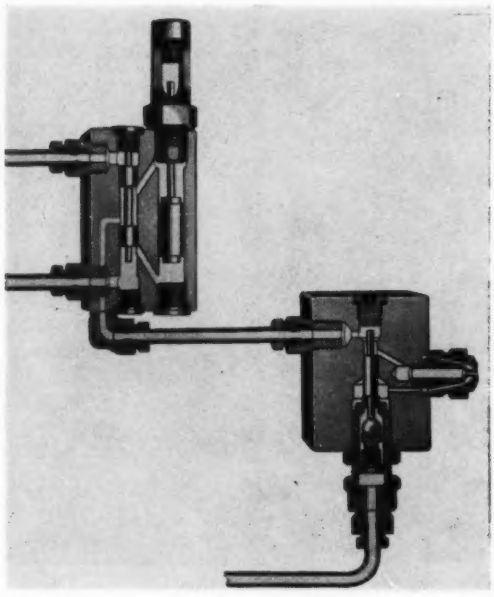


Figure 37

dustries, where a large number of open gear installations exist.

To give you a more intimate knowledge of the mechanics of this device, please refer to Figure 37 where you will see a typical centralized adjustable and indicating metering valve with the discharge line connected to a spray control valve. When the system is operated, instead of the measured quantity of lubricant being discharged to a bearing, it is fed to a spray control valve. The flow of lubricant moves a control piston to open an outlet port to the nozzle, and at the same time a check ball is unseated which permits a flow of air to the nozzle. The air and the gear lubricant are mixed just outside the nozzle tip to form a spray. After the measured quantity of lubricant passes through the nozzle, and is discharged in the form of a spray, the device automatically shuts off until the next lubricating cycle. The lubricating cycles can be controlled manually or automatically. With the adjustable cycling of the system and the adjustable metering valves, any desired quantity of lubricant can be sprayed onto a gear in any given period of time.

Lubrication of open gearing by the spray method is being accepted as the most practical and economical method of application conceived to date.

Conclusion

In conclusion, I would like to review briefly the broad field of equipment and ideas covered in this discussion.

1. Initially, it was pointed out that the consensus of opinion indicates that the most important goals to be achieved with modern methods of lubricant application are:
   a. Safety of personnel
   b. Uninterrupted production
   c. Extended machinery life
   d. Good housekeeping
2. The history of lubricating methods and equipment was traced to show how disadvantages in lack of control and dependence on the human element, led to increasing use and universal acceptance of centralized lubrication.
3. There are four, and only four, basic principles around which a centralized lubricating system can be designed. Every student of lubricating equipment should understand these principles.
4. Various types of centralized systems were discussed to illustrate the tremendous flexibility available in system layout to satisfy specific conditions.
5. Electric timing and controls were explained to show how complete protection against system failures can be incorporated along with the timing controls.
6. Recent developments in mist or fog lubrication, gear spray lubrication, and circulating oil lubrication were explained to bring you up to date on the latest developments in the dispensing equipment field.

I would like to leave you with one last thought. This relates to a quotation I saw on the letterhead of a manufacturer which read "The Sweetness of Low Price Never Equals the Bitterness of Poor Quality."

Applying this thought to lubricants and dispensing equipment, we can say that we know of no investment that will produce higher returns than one in good lubricants and high quality lubricating equipment. ■

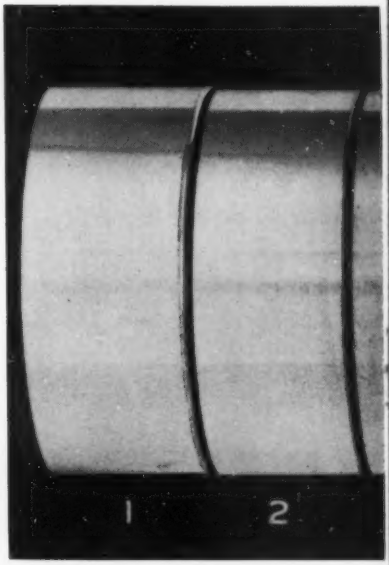
About the Author

E. J. Gesdorf *is a senior application engineer with the Farval Corporation. He attended Penn college and Casi Institute of Technology. Becoming associated with Farval in* 1932, *Gesdorf was then engaged in the manufacture and testing of centralized lubricating equipment. Transferred to the installation department, Gesdorf spent a number of years in the field, supervising the installation of Farval centralized lubricating systems in all types of industries both in this country and in foreign countries. Gesdorf was employed as service manager before taking his present position.*

CRC Laboratory Technique for Determining Rust-Preventative Properties of Lubricating Greases

By E. W. Adams
Standard Oil Company (Indiana)

Figure 1



Introduction

THE U.S. AIR FORCE and the U.S. Navy Bureau of Aeronautics have reported difficulties arising from corrosion in the wheel bearings of aircraft. This subject was of major concern at a conference on Air Force problems held at Wright Air Development Center on October 20, 1949. A CRC panel was formed under the organization shown in Table I. Cooperating organizations are given in Table II.

Some preliminary testing using humidity cabinets at Wright Air Development Center indicated at least variations in the rust-protection properties of the various types of grease then in current use. The assignment was to develop one or more laboratory methods which could evaluate greases as they might be expected to perform in service. The broadest divisions of the problem were: development of a laboratory method and scheme for rating samples; performance testing of the samples in the field; and selection of samples, which are shown below:

Designation	*Specification*	*Fluid*	*Thickener*
RLG-177-50	AN-G-15	Mineral	Sodium
RLG-178-50	AN-G-25	Synthetic	Lithium
RLG-179-50	AN-G-5	Mineral	Sodium
RLG-180-50	AN-G-25	Synthetic	Lithium
RLG-185-51	AN-G-15	Mineral	Sodium
RLG-186-51	AN-G-25	Synthetic	Lithium
RLG-187-51	MIL-G-3278	Synthetic	Lithium
RLG-195-51	AN-G-5a	Mineral	Sodium
RLG-200-52	MIL-G-3278 (*Inhibited Type*)	Synthetic	Lithium

Admittedly it is not easy to acquire controlled-service data. The only existing information was in the nature of complaints rather than controlled or comparative tests on known batches of grease. At an early date field results were needed and were eventually provided by two series of tests by the Service Evaluation Panel. In both test series, the same samples were evaluated.

From the beginning, use of the humidity cabinet was considered. Almost as early it was realized that the precision of this method was poor and not entirely consistent with service conditions. Therefore, dynamic methods, in which condensed, liquid ("free") water was present, were soon considered. Subsequently, because the presence of free water was found to be paramount, dynamic testing was discontinued.

Humidity Cabinet Tests

Initially, the most realistic approach to determining corrosion of lubricated bearings in the laboratory was thought to be testing at constant relative humidity. Humidity cabinets had found favor in testing rust-

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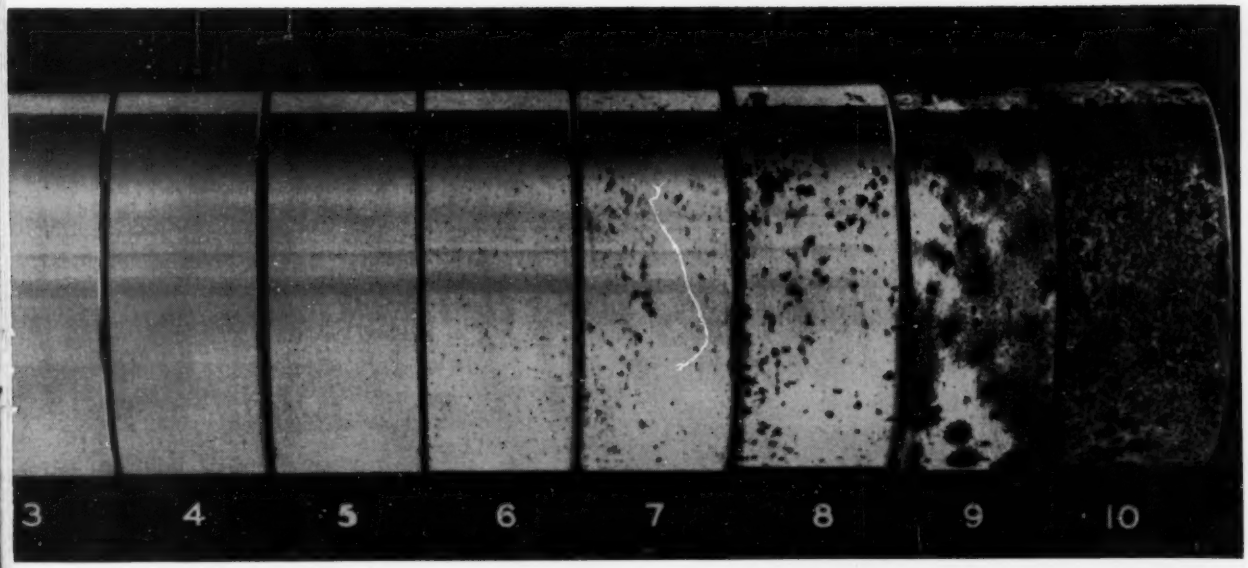

TABLE I

Functional Chart For Coordinating Research Council, Inc.

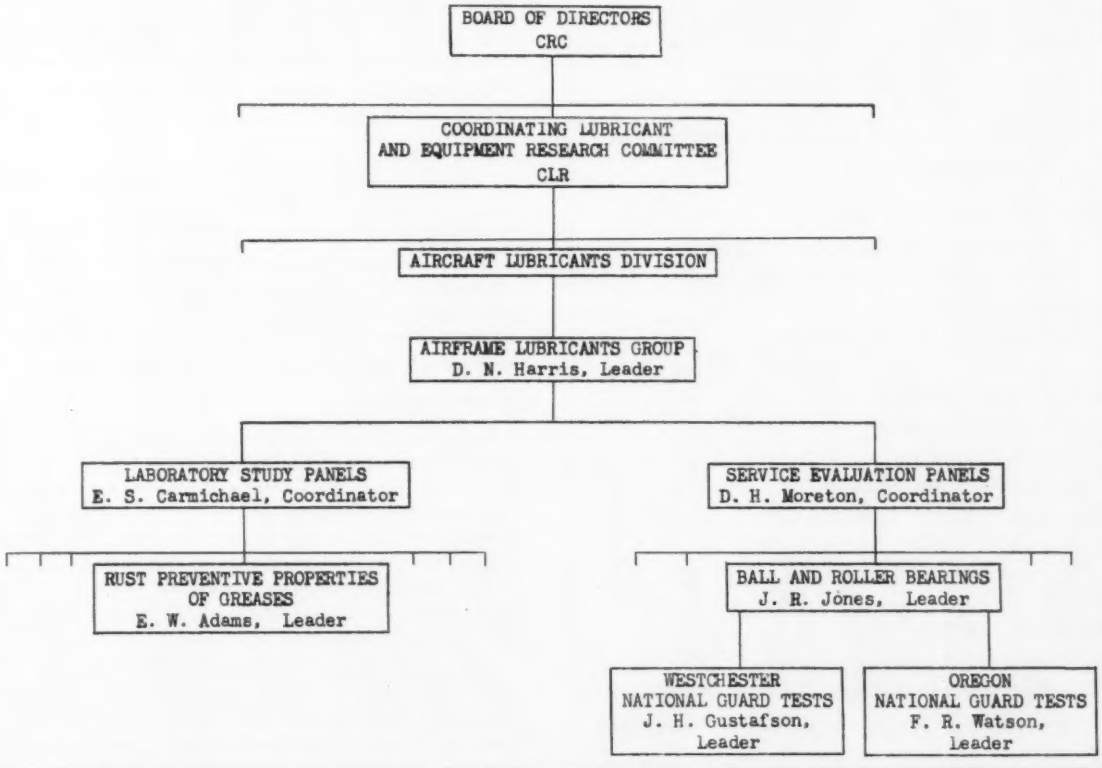

Table II

COOPERATING ORGANIZATIONS

Laboratory Study Panel of Rust Preventive Properties of Greases

E. W. Adams, Leader
Standard Oil Company (Indiana)
Socony Mobil Oil Company, Inc.
General Petroleum Company
Gulf Oil Corporation
Cities Service Oil Company
California Research Corporation
New Departure Division
U. S. Naval Engineering Experimental Station (Annapolis)
The Texas Company
Battenfeld Grease and Oil Corporation
Tide Water Oil Company
The Timken Roller Bearing Company
The Pure Oil Company
Shell Oil Company
Rock Island Arsenal
Union Oil Company of California
Naval Air Material Center (Philadelphia)
Sinclair Research Laboratories
Marlin-Rockwell Corporation

Service Evaluation Panel of Ball and Roller Bearings

J. R. Jones, Leader

Westchester Tests Sub-Panel

J. H. Gustafson, Leader
Socony Mobil Oil Company, Inc.
The Texas Company
Marlin-Rockwell Corporation

Oregon Tests Sub-Panel

F. R. Watson, Leader
Shell Oil Company
Boeing Airplane Company
California Research Corporation
United Air Lines
North American Aviation, Inc.

Project Officers from

Wright Air Development Center
Office, Chief of Ordnance—Fuels and Lubricants
Department of the Navy—Bureau of Aeronautics

preventive oils. By common consent of the committee, a tentative test method for testing greased bearings at constant relative humidity was recommended. Seventeen cooperators tested eight greases by a variety of static methods.

Greases of two series were evaluated in static humidity-cabinet tests. Series-one samples consisted of four greases: RLG-177-50, RLG-178-50; RLG-179-50, and RLG-180-50. The panel agreed that these greases should be tested by the following procedure: A 204-type bearing was packed with 3 grams of the test grease and run in at 1750 rpm for three minutes. Two grams of the extruded grease was wiped off and the outer surface coated with the remainder of the extruded grease. The bearing was placed in a humidity cabinet at 100°F and 95% relative humidity for 30 days. The bearings were examined and rated each day during the test.

The second series of greases consisted of: RLG-185-51, RLG-186-51, RLG-187-51, and RLG-195-51. In addition to the test conditions of the first series of greases, cooperators were instructed to: control the relative humidity at 95 ± 2%; control the temperature at 100° ± 1°F; use rubber gloves when handling the bearings; and shorten the test period from 30 to 28 days.

Complete discussion of the test results as reported by the cooperators brought out the following limitations of static humidity cabinet tests.

1. Different cabinets caused different amounts of condensation on test bearings.
2. Opening the cabinets for daily inspection apparently increased condensation and the severity of the test.
3. Control of relative humidity with good precision was apparently difficult.
4. Only relative ratings correlated with service tests.

It was decided that the technique gave relative ratings in fairly good agreement, but, if the Air Force required absolute ratings, it would be necessary to have a better basis for these ratings. The final tentative method was published as the L-34 Technique.

Dynamic Test Method

In service, bearings are subjected to intermittent rotation in addition to the variables encountered in static laboratory tests. This action redistributes both grease and contaminants, disturbs the pattern of rusting, and grinds the rust on the bearing surfaces and into the grease. Inevitably, variations of a dynamic test were devised in a number of laboratories. These early trials led to the cooperative development of a proposed dynamic test for rust preventives.

The panel conducted three rounds of tests between April, 1952 and November, 1955. The first two rounds were test development while the third aimed at precision of the proposed method. Early results from the dynamic method were evaluated on a relative basis be-

cause service results were not available, and there was no other satisfactory method for comparing dynamic tests with humidity-cabinet and free-water tests.

Basically all three rounds were conducted on a modification of the AN-G-5a water resistance test. In general, a 204 bearing was packed with 4 grams of grease and run for three hours in the water-resistance tester. The bearings were then stored under humid conditions for two weeks. In the first round, aluminum foil was used in the wrapping material. To avoid contact of foil with metal, a polyethylene underwrap was used in the second round. An attempt at better humidity control was made in the third round by storing the run-in bearings in a closed glass jar containing a little water.

CRC ratings from the three rounds provide sufficient data on which to judge the method. Figure 1 illustrates the range in the degree of corrosion used by the several cooperators. CRC-1, or "no corrosion," embraced the 1 to 3 range, CRC-2, or "incipient corrosion," the 4 to 6 range, and CRC-3, all cases of more severe corrosion, such as 7, 8, or 9.

The results were added on the following basis. In round three, two checks out of a possible three form a single rating. Observations were usually made on the rollers or raceways. In round two, check determinations or the poorer result of the two was used. Round one ratings were made on one or two tests as rated by the cooperator or on a rating assigned after reviewing the individual reports or photographs.

The summarized ratings of the five greases, arranged in order of decreasing CRC ratings, are shown in Figure 2. Smaller bars at the bottom represent the results of the individual rounds. The order RLG-200-52, RLG-185-51, RLG-186-51, RLG-195-51, RLG-187-51 clearly selects the inhibited grease, although some CRC-2 ratings were reported. These discrepancies were not resolved by committee action. A trend is indicated for the other samples, of which RLG-187-51 is clearly the worst. It was concluded that the dynamic test adequately rates excellent samples but is not predictable on questionable greases. For this reason and because of the availability of the very similar Free-Water Test, use of the Dynamic Test was discontinued.

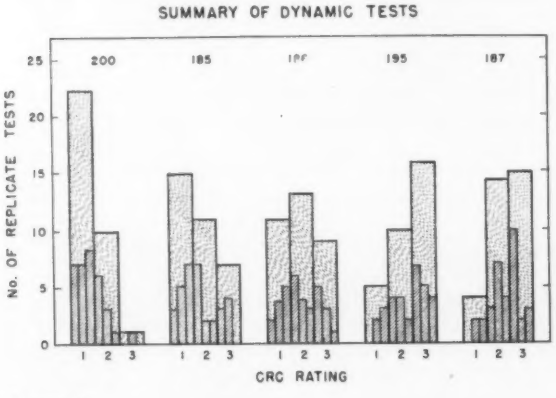

Figure 2

Free-Water Method

The method known as the research technique for determining the rust preventive properties of lubricating greases in the presence of free water includes the same service variables as the Dynamic Method—greasing an antifriction bearing, running-in the bearing, and storing at 100% humidity. However, in this method the run-in period is short and is for the purpose of grease distribution only. This method avoids the less reproducible practice of run-in on the AN-G-5 water-washout tester.

Substantially this same technique had been used by one of the panel members. They reported that greases that corroded rollers in their test also failed in service. Bearing areas that corroded during wet storage deteriorated rapidly when the bearings were replaced in service.

Seventeen members of the laboratory panel made three rounds of tests on the same five samples used in the dynamic trials. Refinements of the method eventually resulted in the proposed method, given in detail in the Appendix. Precision of this final method was investigated on two additional samples, RLG-224-55 and RLG-225-55.

Refinements were made in the areas of technique, number of samples, and experience in rating corroded bearings. Both photographs and corroded bearings were compared.

For each round a single CRC rating by each cooperator can be assigned to each sample. For the third round this is the two-out-of-three check. Checks in the second round, or the poorer of two determinations and information on ease of turning, form the basis for

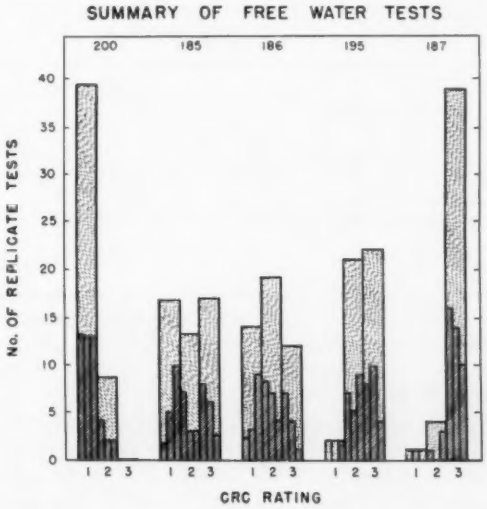

Figure 3

the rating. As in the dynamic trials, the rating assigned in the first round is that originally given by the cooperator or the best opinion based on turning, photographs and comments. The combined ratings are shown in Figure 3. Smaller bars at the bottom represent the results from the individual rounds.

This method consistently separates both inhibited and corrosive greases from the "mine-run" of samples. Ninety per cent of the tests show no corrosion on sample RLG-200-52, and some corrosion on samples RLG-187-51 and RLG-195-51. This would appear satisfactory for specification purposes.

Precision and Expected Utility

The utility of the method will depend upon its repeatability and reproducibility, experience of the operator, and local conditions beyond direct control by the method.

Repeatability may be judged by the results of the third round of tests, shown in detail in Table III. The CRC ratings 1, 2, 3 have no numerical significance and could be A, B, C or good, fair, bad. This has no serious disadvantage in applying the results – we probably could make no use of the fact that one grease permitted rusting of 62% of the bearing area compared with 58% for another–but it prevents standard calculations of precision. Repeatability performance of the panel based on the data in Table III shows that the required two-out-of-three ratings were obtained nearly every time–87% of the way from chance to perfection. A second run, required in the event of no checks among the first three tests, will seldom be required. Identical ratings occur twice as often as pure chance. The method is adequately repeatable.

Reproducibility might be questioned on the grounds that some of these triplicate checks did not meet the consensus, which raises the question of reproducibility and utility of the method. However, reproducibility may also be judged from Table III, which may be reduced to the percentage of cooperators who met the consensus rating or to a go/no-go basis by adding the two and three ratings.

Sample	*RLG-* 200-52	*RLG-* 185-51	*RLG-* 186-51	*RLG-* 195-51	*RLG-* 187-51
Per cent meeting consensus	87	67	64	53	77
Per cent go/no-go	87/13	67/33	64/36	13/87	0+/100–

Either a good or a bad sample should be recognized about 90% of the time. Medium grade greases with CRC 2 ratings will be harder to judge.

Service Evaluation Tests

Laboratory studies directed to finding a satisfactory procedure for measuring corrosion preventive properties of greases were supplemented by two series of service tests. These were conducted by the Service Evaluation sub-panel on Bearing Corrosion in coopera-

Table III

TRIPLICATE TESTS OF FIVE SAMPLES BY FIFTEEN LABORATORIES

RLG-200-52	*RLG*-185-51	*RLG*-186-51	*RLG*-195-51	*RLG*-187-51
1	1	1	2	3
1	1	1	2	3
1	1	1	3	3
1	1	2	2	2
1	3	2	1	1
1	3	3	1	2
1	1	1	2	3
2	3	1	2	3
2	1	1	2	3
1	1	1	2	3
1	1	1	1	3
1	1	1	2	1
2	3	2	3	3
1	3	1	3	3
1	2	2	3	3
1	1	1	3	3
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1	1	3	3	3
1	2	1	3	2
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1	1	1	3	2
1	1	1	1	3
1	1	2	2	3
1	1	1	1	1
1	2	1	2	3
1	1	1	2	2
1	1	1	2	3
1	1		2	
1	1		2	
1	2		2	

tion with Air National Guard units at White Plains, New York, and subsequently, at Portland, Oregon. The test greases were evaluated on F-51's at White Plains and F-86A's at Portland. The F-51 and F-86A planes that completed the test were in the program for nineteen months and five months, respectively.

Each aircraft had three wheels, namely the right and left main wheels, and a tail wheel in the case of the F-51 planes and a nose wheel for the F-86A planes. Each wheel had two tapered roller bearings, all of which were used in the evaluations.

Because of the difficulties inherent in service testing, anything like perfect correlation between laboratory and service evaluations could not be expected. Some of these difficulties were minimized by careful test design. To prevent uncontrollable variables, such as water contamination, operational shock, and rolling loads, from obscuring differences in samples, a statistical technique was employed. For example, in the Oregon tests, a symmetrical orthogonal square was selected. One 5 x 5 square was chosen for one group of five aircraft and an identical design was used for the second group. It was necessary to assign corrosion ratings both to individual aircraft and to bearing locations. Some other factors worth mentioning were: bearing manufacturer, total elapsed time, flight hours, number of flights, and weather.

During the test, periodic inspections were made at both locations. All bearings were finally disassembled and the parts were carefully inspected. Numerical ratings were assigned to the bearing parts, depending upon the degree of corrosion. On this basis, a rating was given to each of the five test greases indicating its relative ability to prevent bearing corrosion under the conditions of test.

Corrosion of bearings was evidenced by conventional black staining, rusting and pitting. Fretting corrosion was not pronounced and was not a problem in the tests. Corrosion occurred with all greases, but not all of the bearings lubricated with a given grease showed corrosion. In bearings indicating corroded areas, those areas were not confined to any particular part or location of the bearing.

When all the factors were taken into account, the final ratings assigned to individual test greases showed good agreement between those assigned in the White Plains series after approximately eighteen months' test time, and those of the Portland series after approximately five months. This agreement is in spite of considerable differences in operating conditions, lubrication intervals, and total flight hours.

Table IV presents the relative ratings assigned to these greases as a result of the test runs at White Plains and Portland. In addition, it presents a combined rating of the two for use in correlating with the laboratory data. The relative ratings given here obviously do not reflect the total range of corrosion conditions found during the test, but merely the order in which the greases were rated with respect to each other, 1 being the best grease and 5 the worst.

Table IV

SUMMARY OF SERVICE TEST RESULTS

Grease	*F-86A Over-all Relative Rating*	*F-51*				*Combined F-51 and F-86A Relative Rating*
		Relative Rating Main Gear	*Tail Gear*	*Weighted Average*[1]	*Over-all Relative Rating*	
RLG-200-52	1	1	1	1	1	1
RLG-185-51	4	3	5	3.7	4	4
RLG-186-51	2	1	5	2.3	2	2
RLG-195-51	5	5	5	5	5	5
RLG-187-51	3	5	1	3.7	4	3

[1] Allowing twice the weight for main gear as tail gear.

Conclusion

Comparing the results of evaluating greases by laboratory and service techniques is not simple. For practical comparison purposes the laboratory and service results were each reduced to a singular set of relative ratings for the greases studied.

The final laboratory rating used in this work was the result of combination of various rounds of free-water data.

The service relative rating resulted from averaging the ratings from F-51 and F-86A planes.

The resulting comparison is as follows:

Grease	*Laboratory Relative Rating*	*Service Relative Rating*
RLG-185-51	2	4
RLG-186-51	3	2
RLG-187-51	5	3
RLG-195-51	4	5
RLG-200-52	1	1

In both tests the inhibited grease (RLG-200-52) was recognized as superior in preventing corrosion. The other four uninhibited greases did not prevent corrosion and were rated inferior to RLG-200-52 by both tests. Rankings of uninhibited greases in the laboratory and service tests did not correlate. This type of result can be expected from greases similar in corrosion-protecting properties.

A method was developed that can select superior corrosion-preventing greases for purposes of the Armed Services. This method, the L-41 Research Technique given in the Appendix, appears to have adequate repeatability and reproducibility to serve as the basis for development of an accepted standard method. Correlation of the test method with service performance tends to confirm its utility.

Acknowledgment

The excellent cooperation of all the panel members and their organizations in carrying out the numerous tests is greatly appreciated. The assistance of E. S. Carmichael, J. R. Jones, L. C. Brunstrum, and R. H. Leet in preparing this report is gratefully acknowledged.

Appendix

Research Technique for Determining Rust-Preventive Properties of Lubricating Greases in the Presence of Free Water

(CRC Designation L-41-957)

This Research Technique has been developed for research purposes only and is not to be construed as a specification or standard, since the Coordinating Research Council, Inc., does not promulgate specifications or standards.

A. Scope

This technique simulates corrosion of grease-lubricated bearings which have been stored after a period of use under wet or humid conditions. The results agree fairly well with such service. While the technique will clearly differentiate between inhibited and uninhibited greases, a great many tests would be required to evaluate borderline greases.

B. Definitions

Corrosion, for purposes of this technique, means any surface damage or rusting of the raceways and rollers or any black stains thereon.

C. Outline of Technique

Clean new bearings are lubricated in a prescribed manner. The bearings are stored two weeks at 77°F and 100% relative humidity. After cleaning, the bearings are disassembled and examined for evidence of corrosion.

D. Equipment

Bearings for use in this test are Timken outer roller bearing cones and cups of the size used on the ASTM wheel-bearing grease tester. The Timken designation for the bearing cone and roller assembly is No. 09074 and for the cup, No. 09196. The container for the bearing is an 8-ounce general-use jar made of flint or

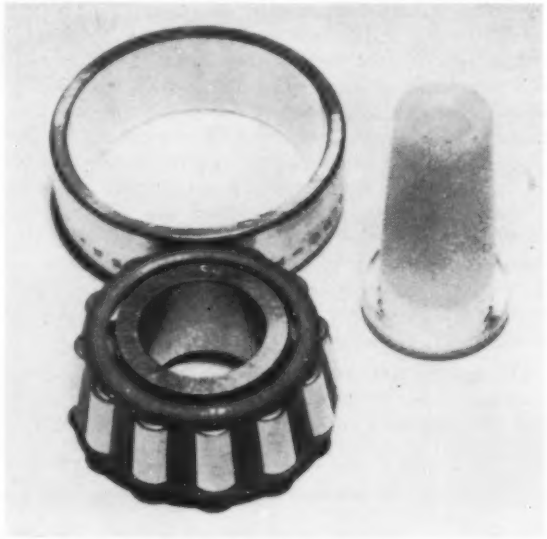


Figure A1 BEARING AND SUPPORT

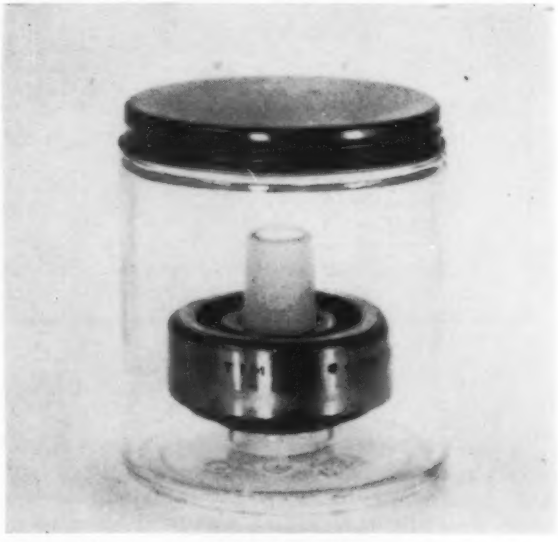


Figure A2 ASSEMBLED UNIT

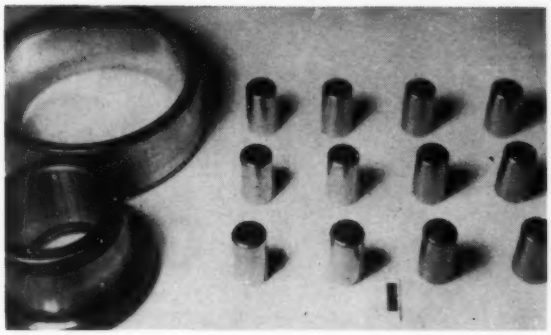


Figure A3 EXAMPLE OF CRC-1 RATING

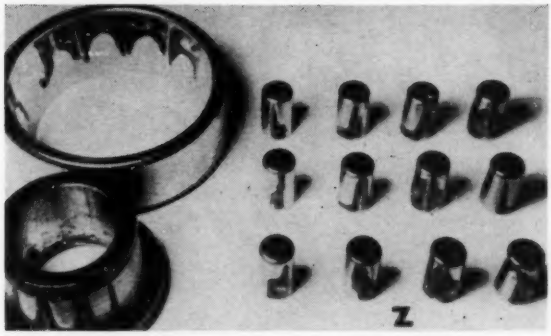


Figure A4 EXAMPLE OF CRC-3 RATING

clear glass and fitted with a wax-lined screw-top cover. Suitable jars are sold by the Owens Illinois Glass Company of Chicago as No. AW-9152 with a No. 70 mm cap. During the test the bearing shall be supported on a 14/35-19/38 standard-taper glass bushing.

E. Test Procedure

Handle, clean, and prepare the bearings in an area free from fumes of any type. Three tests should be made and new bearings used for each test. Carefully examine the bearings and use only those entirely free of corrosion. Remove the rust preventive by two washings in a petroleum solvent such as Stoddard Solvent. Wash the test pieces twice in 99% isopropanol and blow dry with air. During the cleaning process, handle the bearings with tongs to avoid the effects of fingerprints.

Weigh the cone-and-cup assembly to the nearest 0.1 gram. Use clean Neoprene gloves on the hands and apply about 3 grams of grease to the cone and cup, covering all exposed areas and working the grease into the areas around the rollers. By removal of excess and uniform redistribution of sample, adjust the total weight of grease on the cone and cup assembly to 2.0 grams ±0.1 grams. The assembled bearing is then rotated for 1 minute at 1750 rpm, holding the outer cap stationary. Maintain bearing in assembled condition, using care not to break the contact between the races and rolling elements. Place on the pyrex glass fixture in such a manner that the weight of the outer race will maintain contact between the rolling elements. By means of the fixture, dip the entire assembly into freshly boiled distilled water which has been cooled to room temperature, using a new supply of water for each bearing. Place the assembly in the glass jar to which has been added 5 ml of distilled water, tighten the lid firmly and store for fourteen days at 77°F ±1°F.

F. Evaluation

Evaluation is made after cleaning the bearings in a mixture of alcohol and naphtha. Examine the inner and outer race and each roller for pitting and stains.[1] A perfect bearing is rated 1. Incipient corrosion, a few small spots, is judged 2. Anything more than incipient corrosion, including severe corrosion, is judged 3.

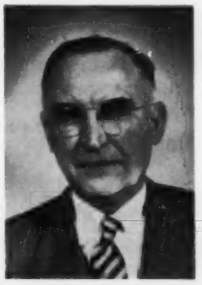
1. If the photographs are desired for future reference or comparison, the following procedure will be found satisfactory. Lay the cup and cone on a white background. Stand the disassembled rollers on end in two rows at one side of the cup and cone. Turn all of the worst corroded areas toward the camera. Illuminate from above with a diffused 150 watt reflector lamp. Photograph at an angle of about 50° and print full size on glossy paper. If the ratings on two or three of the bearings agree, report this number for the sample. If all three are different, repeat the test.

G. Precision

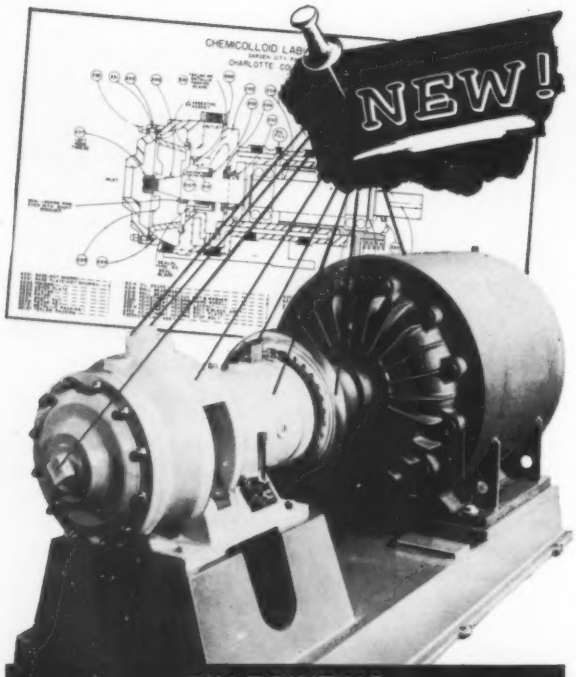
Repeatability may be judged by the fact that, when testing five samples, fifteen laboratories got check tests (at least 2 out of 3) 98% of the time.

Reproducibility may be judged by the fact that, during these tests, 87% of the laboratories matched the consensus on a good sample, but tapered to 53% on a poor sample. ■

About the Author



E. W. Adams *is associate director of research in the Whiting Laboratories of Standard Oil company (Indiana). After receiving a Ph.D. degreee in organic chemistry from the University of Wisconsin and spending some time in the academic field as professor of chemistry, he joined the staff of his present company in* 1925 *as research chemist. He served in various capacities and was named to his present position in* 1950. *He had previously received an A.B. in education from Western Illinois State college and a B.S. and M.S. in chemistry from the University of Illinois. He is chairman of the NLGI Research Fellowship Committee and a member of Sigma Xi, ACS, and API.*



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Technical Committee Column

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The NLGI fundamental research committee has finalized its symposium on rheology to be held at the Annual Meeting. The time for the symposium has not yet been decided except that it will be during the first two days of the Annual Meeting rather than part of the Technical Committee meeting. However, it is planned to assign a half-day thereto paralleling that part of the Annual Meeting where marketing-type papers will be presented so that the competition between the two sessions will be minimized. Just a quick glance at the authors and papers listed below should be sufficient to show that this symposium will be the best ever held on the subject of rheology of lubricating greases:

Author	Title of Paper
Prof. W. A. Bauer *Rensselaer Polytechnic Inst.* *Department of Chemistry* *Walker Laboratory* *Troy, New York*	*Comparison of Temperature Effects on the Flow Properties of Greases in Capillary and in Cone and Plate Viscometers.*
Dr. Henry Eyring, Dean *Graduate School* *University of Utah* *Salt Lake City, Utah*	*Pressure and Temperature Effects on the Flow Properties of Grease.*
A. W. Siske, L. C. Brunstrum, and R. H. Leet *Standard Oil Company (Ind.)* *Research Department* *Whiting, Indiana*	*An Equation Fitting the Flow of Lubricating Grease in Viscometers and Pipes.*
Mr. J. L. Dreher *California Research Corp.* *Richmond Laboratory* *Richmond, California*	*Yield Points of Lubricating Greases*

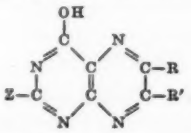
In addition to the papers, time will be provided for a question and answer period.

NLGI SPOKESMAN

Patents and Developments

Lubricating Oils Thickened With Pteridine Derivatives

Patent 2,822,334, issued to E. A. Swakon, D. Krehbiel, and J. C. Goossens, assigned to Standard Oil Company (Indiana). Novel greases are prepared from lubricating oils thickened with 10-50 per cent of a high melting pteridine derivative having the general formula:



in which Z is selected from the radicals OH and NH_2, and R and R′ are mononuclear and binuclear aromatic groups having alkyl, nitro or halogen substituents. Examples of suitable compounds include 2-amino-4, 6, 7-trihydroxy pteridine (leucopterin), 2-amino-4-hydroxy pteridine, 2-amino-4-hydroxy-6, 7-diphenyl pteridine and 2-amino-4-hydroxy-6, 7di (2chlorophenyl) pteridine. In particular, superior products are claimed to be produced when use is made of silicone polymer oils as the lubricating medium. Other suitable oils are a trifluorovinyl chloride polymer marketed as "Fluorolube" by Hooker Chemical Company and trifluoro-chloroethylene polymers sold as "Kel-F-40" by M. W. Kellogg Company.

Stabilized Aerogel Thickened Greases

Patent 2,820,763 issued to E. C. Hughes and E. C. Milberger, assigned to The Standard Oil Company (Ohio). The grease composition thickened with the aerogel (e.g., silica), has incorporated therein a water-miscible amine having at least two polar groups, such as a hydrophobic cationic surface-active water stabilizer in the form of Amine "O" (1-betahydroxyethyl 2-heptadecenyl imidazoline), in an amount of 0.1-5 per cent, depending upon the water stabilizing effect desired, the nature and amount of the gelling agent used, and the economics involved. Suitable gelling agents are "Santocel AR", Linde Silica Flour, "Ludox" silica, and "Fumed Silica."

Patent 2,820,764, issued to the same patentees is similar to the previous patent with the exception that 0.25-1 per cent of a hydrophilic polyhydric alcohol is added to improve high temperature stability without markedly affecting the consistency of the thickened lubri-

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cant. The alcohol preferably has 2-8 carbon atoms and at least two hydroxyl groups. Examples include ethylene glycol, diethylene glycol, glycerol apha-monomethy ether, dulcitol, glycerin chlorohydrin and polymeric dihydroxy polyethers derived by condensation of ethylene oxide or propylene oxide, containing 2-10 oxide units.

Patent 2-820,765, issued to the same patentees is similar to the first-mentioned patent with the exception that there is added 0.25-1 per cent of a water-miscible ether having two polar groups, of which at least one is an ether group and one at most is a hydroxyl or amine group. Examples include monomethyl ether of diethylene glycol, dimethoxy tetraethylene glycol, and beta, beta'-diamino-diethyl ether.

Synergistically Improved Soap-Thickened Greases

Patent 2,820,008 issued to H. A. Woods and H. M. Trowbridge, assigned to Shell Development Company. Corrosion-resistant greases having greater mechanical stability are prepared by use of a minor proportion of metal soap synergistically improved with a combination of mono (aliphatic carboxylic acid) esters of polyoxyalkylene glycols (wherein each oxyalkylene radical contains 2-6 carbon atoms) and alkaline earth metal hydrocarbyl sulfonates. When each member of this combination is present in an amount of 0.1-5 per cent by weight of the total grease, unexpected prolongation of the useful bearing life of the grease is claimed, accompanied by unexpected resistance to washing or emulsification by water. The polyalkylene glycol monoesters have the general formula

$$H\text{-}(O\text{-}R)_n\text{-}O\text{-}\overset{\overset{O}{\|}}{C}\text{-}R_1$$

wherein R is an alkylene radical having 2-6 carbon atoms, R_1 is an alkyl radical having 8-24 carbon atoms, and n is an integer between 5 and 20. Preferred esters have molecular weights between 150 and 2000, and include polyethylene glycol, polypropylene glycol, etc. The alkaline earth metal hydrocarbyl sulfonates are generally known as petroleum sulfonates obtained during acid treatment in the preparation of electrical insulating oils, turbine oils, etc. Oil soluble mahogany sulfonates are preferred in the molecular weight range of about 400-750. Examples describe lithium 12-hydroxy stearate greases treated in this manner and stabilized with zinc dibutyl dithiocarbamate.

Stable, Thermally-Reversible Greases Containing Guanidine Sulfonate

Patent 2,823,182 issued to G. D. McLeod and W. L. Rittschof, assigned to Standard Oil Company (Indiana). Stable, thermally-re-

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versible greases are claimed to be produced by thickening lubricating oils with 1-20 per cent of a guanidine sulfonate made with oil-soluble or water-soluble petroleum sulfonic acids having a molecular weight of about 350-525. Particularly suitable, are the guanidine salts of mixed alkanesulfonic acids, such as a mixture of methanesulfonic, ethanesulfonic and propanesulfonic acids having an average molecular weight of 110-115. Sulfonic acids obtained by the sulfonation of olefin polymers having at least 22 carbon atoms per molecule also may be employed. Some examples include the use of some (2-10 per cent) sodium mahogany soap with the guanidine salts of preferentially oil-insoluble sulfonic acids.

Mixed Hydroxy Fatty Acid-Unsaturated Fatty Acid Thickened Greases

Patent 2,820,762 issued to L. F. King and assigned to Esso Research and Engineering Company. Washing-out-resistant antifriction bearing greases particularly suitable for lubricating railway car journals and heavy machinery for long periods of time are prepared by replacing 15-25 per cent of the sodium soaps of hydroxy fatty acids, e.g. 12-hydroxy stearic acid, with soaps of unsaturated fatty acids in the C12-C22 range, such as oleic, acidless tallow or cottonseed, in combination with 0.5-4 per cent (of the total soap) of trisodium phosphate complexed with the soap, and 0.2-1 per cent of glycerine, plus a trace of water. The unsaturated acid soap eliminates hardening tendency and improves mechanical stability. The iodine number of the mixed acids is 15-40, and the lubricating oil used should have a viscosity index of at least 50. It is pointed out that a distinct change occurred in the type of dispersion of soap particles during the heating and cooling cycle. The grease was the soda-lime base product, the soap being derived from 12-hy-

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droxystearic acid, containing about 1 per cent sodium phosphate. Long soap crystals which existed in the original grease were disrupted and broken down into much shorter ones by the test procedure. The very small amount of water, much less than stoichiometrical proportions, indicates that hardening is not due simply to hydration of the soap. The replacement of a portion of the hydroxy fatty acid with unsaturated fatty acid, however, eliminated this hardening tendency in presence of a small amount of water.

Greases Containing Chlorovinyl Phosphates

Patent 2,824,839 issued to G. C. Templeman, assigned to The Ohio Oil Company. Film strength improvement of oils and greases is claimed by the addition of 0.01-10 per cent of a di(beta-halo-ethyl) vinyl phosphonate, such as di(beta-chlorethyl) vinyl phosphate which is claimed to be readily available commercially.

Industry News

Jesco Announces the Purchase of the Ohio Grease Company

The purchase of the Ohio Grease company, Loudonville, Ohio, was announced this month by Claude L. Johnson, president of Jesco Lubricants company, 1437 Gentry, North Kansas City, Missouri.

Johnson stated that the Ohio Grease company would continue to operate as a separate corporation, under the present management. The Ohio organization was founded in 1908 and distributes industrial lubricants under the "Lubricream" brand in the east and in the south. Steam cylinder lubricants are also a well known specialty.

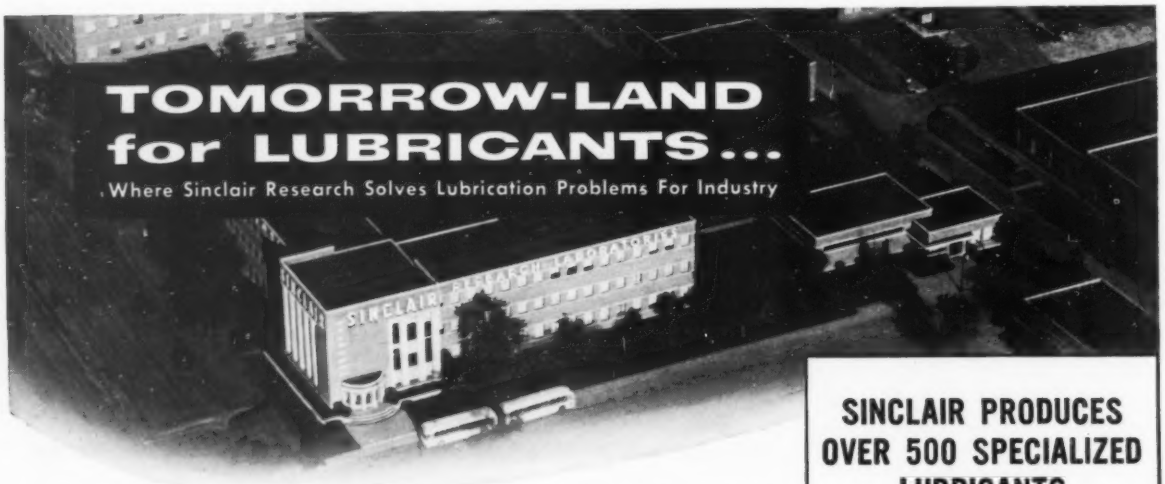
Plans for modernization and improvement will begin immediately, Johnson stated. Continuous progress is planned for the manufacturing facilities. A plant with 35,000 square feet of working space is among the Loudonville assets.

Warehouses are located in Philadelphia, Chicago, Cincinnati, Memphis, Shreveport, New Orleans, Charlottesburg, Kentucky and Charleston, West Virginia.

Jesco, founded in Kansas City in 1929, is a well known midwest lubricants specialties manufacturer. Johnson is president and founder, E. R. "Dixie" Howell is executive vice-president and treasurer, and J. J. Dickason is vice-president and chief chemist.

Sturaco XL EP Base for Hypoid Gear Lubricants

Sturaco XL has been announced as a new and improved base for hypoid gear lubricants by the automotive lubricants division of D. A. Stuart Oil Co., Limited, 2727 South



Located at Harvey, Illinois, is one of the most extensive installations of its kind in the world—Sinclair Research Laboratories. These facilities are an important part of Sinclair's investment in the future. Here is where Sinclair engineers and chemists work to develop new products and improve the quality of existing ones. At these famous laboratories were developed the Sinclair lubricants now solving difficult problems in all branches of industry. If you have a special lubrication problem, write today to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y.

SINCLAIR PRODUCES OVER 500 SPECIALIZED LUBRICANTS for

TURBINES
DIESEL ENGINES
PLANT MACHINERY
METAL WORKING
AUTOMOTIVE EQUIPMENT
and many other applications

SINCLAIR REFINING COMPANY

Troy street, Chicago 23, Illinois.

The product is a sulphur-chlorine-lead lubricant base that has been approved for all principal heavy-duty automotive specifications, including Ford Motor company (M2C28A&B; M4642D&E), General Motors corporation (GM-4735M), and Chrysler corporation (MS-1220).

Specifications for Sturaco base oil are: 4.8 per cent Min. sulphur; 4.2 per cent Min. chlorine; 6.0 per cent Min. Lead; 40 per cent Min. Saponifiable; 10-12 API gravity, and 8.22 to 8.33 lbs. per gallon. 10 per cent by weight of Sturaco XL base in SAE 90 stock carries 50 lb. minimum Timken machine lever load; 28.5 per cent base carries an 80 lb. minimum load.

Sturaco is available by tank car or drum, F.O.B. Chicago or Bayonne, New Jersey.

Specification literature is available upon request to the manufacturer.

Chart Tells Machine Shop Personnel Where to Use Molykote Lubricants

Bulletin 116, published by the Alpha-Molykote corporation, Stamford, Conn., contains a valuable chart for machine shop personnel to show where and how Molykote lubricants should be applied.

The chart indicates the equipment on which the lubricant promises to excel, the method of applying the lubricant, and the benefits which can be expected.

Copies are available from the Alpha-Molykote corporation, Stamford, Connecticut.

Hummel Chemical Offering Barium Hydrate

Hummel Chemical company, 90 West street, New York 6, New York, is now offering barium hydrate (barium hydroxide octahydrate). This chemical is used in the manufacture of high detergency motor oils and barium greases. It is also used in the manufacture of barium additives which in modern automotive engine oils acts as detergent dispensers and acid neutralizers, prevent sludge and varnish from depositing on piston rings, bearings, cam shafts, and other vital moving parts.

B_2O	46.5-47.0%
$BA(OH)_2\ 8H_2O$	95.0-96.5
$BaCo_3$	1.5- 2.5
$SiO_2 + Al_2O_3$	traces
Fe	0.004
Cl	0.002 max.

Stockholders Change Name To Chemetron

National Cylinder Gas company changed its name to Chemetron corporation on May 7, in Chicago.

The new name became official at the company's annual meeting when stockholders voted adoption of a resolution amending the certificate of incorporation.

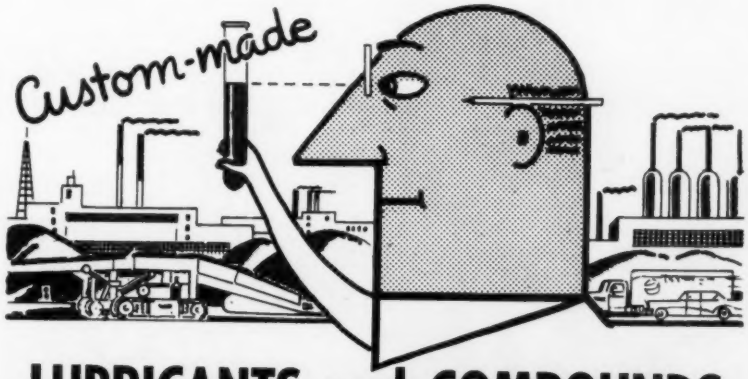
President Charles J. Haines said one of the firm's seven divisions would now bear the 23-year-old "National Cylinder Gas" name. He said the company as a whole had outgrown it through the years by continuing diversification and expansion.

"Chemetron" is a contraction of the names of three of many industries served by the company—chemicals, metals and electronics—and was selected from thousands of suggested names in a five-year search.

Other divisions are the Tube Turns division, Pennsylvania Forge division, Perforating Guns Atlas division (subsidiary operating as division), Girdler Construction division, Girdler Process Equipment division and Chemical Products division.

Tidewater's Lubes To Be Labeled "Veedol"

Tidewater Oil company's line of industrial lubricants will be identified by the "Veedol" label in the future, it was announced recently



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Increasing responsibilities placed upon lubricants by modern equipment are a challenge that we are pleased to accept. Special oils and greases are developed in our laboratories for any requirement.

AMERICAN LUBRICANTS INC.

Independent Wholesale and Industrial Producers

1575 CLINTON ST., BUFFALO 6, N. Y. Since 1922

by J. G. Jimenez, eastern division marketing manager.

The change in name from "Tycol" is being made to achieve a uniform nomenclature for Tidewater's first-line lubricants in general use.

The changeover became effective April 15, affecting all products presently branded "Tycol" with the exception of Tycol Amultone 15 and Tycol Aturbol 102, which will remain unchanged.

Newest Air Operated Pumps in 20 Years Described in Lincoln Catalog

A new catalog featuring the "newest line of air-motor operated lubricant pumps on the market in twenty years" is being offered by Lincoln Engineering company of St. Louis, Missouri.

Fully illustrated, the two-color catalog covers design and engineering features for the complete series of Lincoln's 67 new "Power-Master" pumps and allied equipment, including the "Dyna-Ram" air operated pressure primer for pumping extra heavy lubricants and "non-flowing" compounds; the Lincoln "Pile Driver," a maximum power air operated pressure primer; and the super-volume "Niagara" Pump, designed to fit all of the new "Power-Master" air-motors.

Complete with lubricant-output-performance and selection charts on the "Power-Master" series, this new catalog describes how the pumps can furnish industry a complete range of dependable, high-performance pumps that handle all materials . . . from light oils to heavy fibrous greases and viscous coatings, sealers and mastics.

A special section in the catalog details the major reasons why "Power-Master" assures top performance, long service life, maximum economy, and unmatched versatility. Particular reference is made to high volume output, sturdy construction, precision manufacture, easy maintenance, light weight, quiet operation, and industry-wide applications.

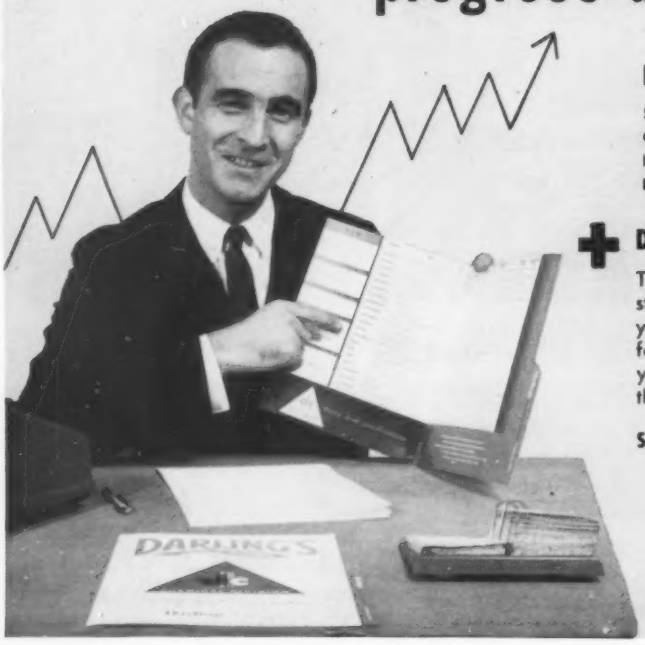
The new "Power-Master" series, according to the catalog, is available in nineteen pressure ratios to meet all industrial requirements.

Copies of the new catalog may be obtained by writing for Lincoln Catalog No. 65, Lincoln Engineering company, 5702-30 Natural Bridge avenue, St. Louis 20, Missouri.

Petroleum Packaging Committee Publicity Report

The Petroleum Packaging committee representing the American Petroleum Institute lubrication committee, the National Lubricating Grease Institute and the Packaging Institute met on March 24 in the Chalfonte-Haddon Hall hotel,

The magic ingredients that mean progress and profits for you!



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STEARIC ACID
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The laboratory research staff at Darling is constantly developing new products and will work with you in improving yours—this is our two-fold reason for existence. Whatever your problem, whatever your goal . . . Darling research can help you get there faster!

Send for Product Specification Folder!

DARLING & COMPANY

4201 S. Ashland Avenue, Chicago 9, Illinois

Atlantic City, New Jersey. This date was selected to give members the opportunity of visiting the exposition of Packaging Machinery Manufacturers Institute.

The annual election of officers was a feature of this meeting. The slate presented by the nominating subcommittee, Mr. R. W. Henry, chairman, was elected unanimously. The new officers are:

Mr. Fred J. Beck, packaging coordinator, Cities Service Oil Co., New York City, chairman.

Mr. Robert Rutherford, packaging engineer, Sun Oil company, Philadelphia, vice-chairman.

Mr. L. E. Stuart, director, product costs, and pricing, Continental Oil Co., Houston, Texas, secretary-treasurer.

A vote was taken on a proposal to change the frequency of meetings and the decision reached was to have three meetings a year instead of four as in the past. These will be scheduled for February, June and October of each year.

The schedule of meetings for the next year as proposed by the Program Subcommittee were approved as follows:

Toledo, Ohio, Commodore Perry hotel, June 3rd, 4th, 1958.

Omaha, Nebraska, October 6th, 7th, 1958.

Port Arthur, Texas, Goodhue hotel, Feb. 16th, 17th, 1959.

Vulcan Containers Expands Production With Two New Sizes of Drums

Vulcan Containers, Inc., pioneer steel shipping container manufacturer, has expanded its production to include new open head grease drums and 15 gallon open and tight head drums with the new universal diameter of 13 15/16 inches as a production standard.

The new standardized line of drums, which comply with federal, military, and Interstate Commerce Commission specifications, will greatly streamline and simplify warehousing and distribution operations of such basic users of steel packaging as the chemical, adhesives, industrial maintenance supplies, and petroleum products industries, according to George E. McMahon, executive vice-president of Vulcan.

The 41-year-old Bellwood, Ill., steel container manufacturing firm is producing full open head grease drums in 100, 110 and 120 pound, and 14, 15 and 16 gallon capacities. These drums are available with 20 lug covers, lever or bolt-locking ring closures, and drop side handles. Vulcan's 15 gallon tight head drums have recessed heads and can be obtained with a wide selection of openings, although ¾" to 2" are standard.

All drums are available with plain steel, rust preventative or hi-bake protective interiors; indented to provide higher stacking; painted solid colors, striped, lithographed or silk screened to meet customer requirements.

Sonneborn of Maryland Moves, Expands Baltimore Warehouse and Sales

Relocation and expansion of the Baltimore sales offices and warehouse facilities of L. Sonneborn Sons of Maryland, Inc., to meet increased customer demands for Sonneborn white oils, petrolatums, and petroleum sulfonates in the Maryland and Virginia areas has been announced by R. W. Bjork, sales manager for L. Sonneborn Sons, Inc., N. Y., petroleum refiners and manufacturing chemists.

Offices and warehouse of the Sonneborn Maryland subsidiary have been moved to 2800 Annapolis road, Baltimore, from their previous location at 513 Lombard street, Baltimore. John D. Sullivan is manager.

Almost everything that moves either in actual operation or in the process of its making . . . from gate hinges to tractor wheels . . . depends upon grease. That is why lubricants should be bought with care. You can always depend upon Deep Rock highest quality greases and lubricants. They are manufactured to give **top lubrication to all moving parts.**

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American Flange & Manufacturing Company, Inc.
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Representative—Richard L. Parish, Jr.

Bennett Industries
Peotone, Illinois
Representative—S. A. Bennett

Central Can Company
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Representative—Henry Frazin

Cleveland Container Company
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Representative—R. D. Sayles

Continental Can Company, Inc.
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Representative—W. J. Flint

Geuder, Paeschke & Frey Company
324 North Fifteenth St., Milwaukee 1, Wis.
Representative—Neil Savee

Inland Steel Container Company
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Representative—J. Daniel Ray

Jones & Laughlin Steel Corporation
Container Division
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Representative—C. K. Hubbard

National Steel Container Corp.
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Representative—Henry Rudy

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Representative—Lawrence F. McKay

Republic Steel Corporation
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Representative—Theodore Humphrey

Rheem Manufacturing Company
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Representative—F. J. Blume

Rieke Metal Products Corporation
Auburn, Indiana
Representative—Mahlon E. Rieke

Steel Package Division of National Lead Company
722 Chestnut Street, St. Louis 1, Missouri
Representative—Warren T. Trask

United States Steel Products
Division, United States Steel Corporation
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Representative—Wm. I. Hanrahan

Vulcan Containers, Inc.
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Representative—L. M. Ferguson

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Representative—Lee Witzenburg

Gray Company, Inc.
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Representative—B. A. Beaver

Lincoln Engineering Company
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Representative—G. A. Hubbard

Stewart-Warner Corporation
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Representative—E. G. Wicklatz

Sumner Sollitt Co.
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Representative—A. J. Barth

Trabon Engineering Corp.
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Representative—E. W. Baumgardner

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Balmain, New South Wales, Australia
Representative—L. Ashley

California-Texas Oil Company
380 Madison Ave., New York 17, New York
Representative—Hal U. Fisher

Canadian Petrofina Limited
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Montreal, Quebec, Canada
Representative—M. E. Wight

Cooperative GLF Exchange, Inc.
Terrace Hill, Ithaca, N. Y.
Representative—W. S. Miller

Denco Petroleum Company
5115 Denison Avenue, Cleveland 2, Ohio
Representative—I. L. Carmichael

Derby Refining Co.
420 West Douglas, Wichita, Kansas
Representative—W. B. Neil

D-X Sunray Oil Company
Mid-Continent Bldg., P.O.Box 381, Tulsa, Okla.
Representative—J. W. Basore

Farmer's Union Central Exch., Inc.
P. O. Box G, St. Paul 1, Minnesota
Representative—H. F. Wagner

Illinois Farm Supply Company
100 East Ohio Street, Chicago, Illinois
Representative—S. F. Graham

Ohio Farm Bureau Cooperative Association, Inc.
245 North High Street, Columbus 16, Ohio
Representative—Walter N. Callahan

Valvoline Oil Company
Division of Ashland Oil & Refining Co. Box G
Freedom, Pennsylvania
Representative—D. A. Smith

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

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Representative—George J. Barrett, Jr.

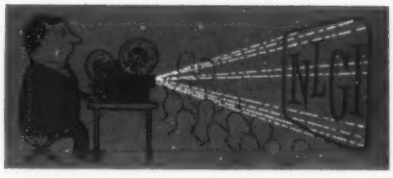
Chemicolloid Laboratories, Inc.
55 Herricks Road, Garden City Park, N. Y.
Representative—David F. O'keefe

The Girdler Company
A Div. of National Cylinder Gas Co. Box 987
Louisville 1, Kentucky
Representative—J. E. Slaughter, Jr.

Manton-Gaulin Mfg. Co., Inc.
44 Garden Street
Everett 49, Massachusetts
Representative—J. J. Dwyer

Morehouse-Cowles, Inc.
1156 San Fernando Rd., Los Angeles, Calif.
Representative—George E. Missbach

nlgi



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Struthers Wells Corp.
1003 Pennsylvania Ave. West, Warren, Pa.
Representative—K. G. Timm

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Representative—B. H. Loper

American Potash & Chemical Corp.
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Representative—W. F. O'Brien

Archer-Daniels-Midland Company
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"GREASE—THE MAGIC FILM" tells in 25 fast-moving minutes the wonderful story of lubricating grease, how this magic substance makes modern mechanical progress possible, and of the research and testing to insure a constantly better product. The 16mm movie, subsidized by NLGI, in sound and color, can also be obtained for foreign voice narration.

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Godfrey L. Cabot, Inc.
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Boston 10, Mass.
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The Lubrizol Corporation
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The McGean Chemical Corp.
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Metasap Chemical Corporation
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Monsanto Chemical Company
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Representative—R. Gillerot

Petroleum Educational Institute
9020 Melrose Avenue, Los Angeles 46, Calif.
Representative—G. A. Zamboni

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill.
Representative—Mrs. G. A. Krawetz

Products Development Laboratory
1 Market St., West Warwick, Rhode Island
Representative—Alberic T. DiMasi

Veresit—Fabrica de Productos Quimicos S.R.L.
Monasterio 271, Buenos Aires, Argentina
Representative—Dr. Alexander Erdely

Socony Announces New Multi-Service Grease

A new multi-service grease which means cost savings for industrial plants because it combines the advantages of many different greases into one product, was announced recently by Socony Mobil Oil company, Inc.

The new product, Mobilplex EP (for extreme pressure), is the result of more than a decade of experimentation as well as field testing.

Cost savings are possible because one grade of grease can now be used in many different machines in place of a variety of special purpose greases, according to the announcement.

Light tan in color, the new product is a calcium-EP-complex grease which withstands extreme pressures, has long service life, is water-resistant and at the same time maintains chemical stability despite temperatures from minus 15 degrees to plus 300-degrees F. It also protects against rust and corrosion, is compatible with other types of greases, lasts longer and lubricates better than conventional products, the announcement said.

Wear—Usure—Verschleiss

An international journal on fundamentals of friction, lubrication, wear, and their control in industry is now being published by the Elsevier Publishing company, Amsterdam.

Vol. 1 (1957/1958) of WEAR announces the aim of this new technical journal should be obvious from the sub-title and from the list of well known experts who make up the very cosmopolitan editorial board—it is to report on basic research on friction, lubrication, and wear, and the application of the results to industry.

The first three issues (August, October and December, 1957) and the titles of papers now being prepared for publication give a fairly clear picture of the field of wear research, ranging from physical-theoretical studies to industrial aspects. Original papers as well as critical review articles deal with frictional properties and wear-resistance of metallic, inorganic and organic materials under laboratory and working conditions. This exchange of knowledge in English, French and German between experts from Australia, Japan, India, the Soviet Union, U.S.A. and Europe, is supplemented by a compact section containing abstracts and brief reports on current events.

Vacation Schedules for Nopco and Metasap Announced

The annual two-week vacation of plants of the Industrial Manufacturing Division of the Nopco Chemical company and its subsidiary, the Metasap Chemical company, has been announced.

Shutdown of Nopco's various plants will be as follows:

Cedartown, Ga.—July 4th through July 20th

Richmond, Calif.—July 4th through July 20th

Harrison, N. J. — August 16th through September 1st

Nopco and Metasap customers have been urged to place their orders well in advance to avoid delays in shipping during the vacation periods.

HARSHAW LEAD BASE

Harshaw Lead Base, as an additive to petroleum lubricants, improves extreme pressure characteristics and imparts the following desirable properties:

- Increased film strength
- Increased lubricity
- Improved wetting of metal surfaces
- A strong bond between lubricant and metal surfaces
- Resistance to welding of metals at high temperatures
- Moisture resistance and inhibits corrosion

Harshaw Lead Bases are offered in three concentrations to suit your particular needs:

Liquid 30% Pb	Liquid 33% Pb	Solid 36% Pb

Other metallic soaps made to your specifications. Our Technical Staffs are available to help you adapt these products to your specific needs.

THE HARSHAW CHEMICAL CO.
1945 E. 97th Street • Cleveland 6, Ohio
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LET US MODERNIZE YOUR PLANT

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"In Engineering it's the People that count"

FISKE BROTHERS REFINING CO.

Established 1870

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NEWARK, N. J.

TOLEDO, OHIO

★

Manufacturers of

LUBRICATING GREASES

People in the Industry

Chairman of E. F. Houghton Board Edits Company Magazine

Ever hear of the chairman of the board of a large industrial concern who edits the company magazine? Does a tremendous job of it? And then denies his worth as an editor?

Major Aaron E. Carpenter, chairman of the directors of E. F. Houghton & Co., Philadelphia, has been doing all three of these things for the past 21 years. During this period, he has been what he calls "near-editor" of *The Houghton Line*.

The *Line*, which celebrated its 50th anniversary in April, is one of the best known and widely read company externals in the country. It is the fifth oldest publication of its kind in the nation, and has a circulation of slightly fewer than 200,000. Four distinct editions are issued monthly to the textile and paper mills, the metal working market, and general industry concerned with hydraulics and lubrication.

Why does the Major call himself "near-editor"? It's because he, like his father, the first *Line* editor, considers himself a "poor imitation of the real thing." He refers to himself simply as a plain businessman who never had any real training in editing. But he gets a big kick out of his correspondence from all over the world and makes it a point to answer every letter personally. In that way he has developed a host of mail friends, most of whom he has never met face to face.

Emery Men Move

The New York sales office of Emery Industries, Inc., moved to new quarters at 1 Exchange Place, Jersey City 2, New Jersey, effective May 1.

The new office will serve as headquarters for Harry D. Armitage, Robert J. Roberts and Robert S. DeLollis, fatty acid sales representative, and George R. Williams and Robert S. Haley, organic chemical sales representatives.

The office handles Emery Industries' full line of chemical products, which includes fatty acids and hydrogenated glycerides, dibasic acids, fatty esters, placticizers, textile chemicals, esters for synthetic lubricants, soluble oil bases, and fat splitting reagent.

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You can always count on Penola for the best in industrial and automotive lubricants. Manufactured and packaged to your exact requirements, Penola lubricants are readily available for sale under your own house brand. Our plants are strategically located to serve you better. Write or phone for complete information.

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Achilles Heads New Tidewater Technical Service Section

Tidewater Oil company, eastern division, has formed a new technical service section within its lubricants supply department, in a program to streamline operating procedures.

The new section centralizes the technical service functions formerly handled by the marketing and technical services departments and eliminates some duplication of effort, company spokesmen said.

Harold E. Achilles has been named section supervisor. He formerly was assistant coordinator of the division's manufacturing department. Lawrence N. Tucker, formerly of the technical service department, is assistant supervisor. Other staff members are: Hal C. Gooch, former technical service supervisor in the marketing department, now senior lubricants engineer of Tidewater; Stanley P. Waugh and Everett C. Post, formerly of technical service, are lubricants engineers.

The new technical service section operating at division level will perform technical service and customer relation functions, and will be responsible for new lubricating product developments as well as quality control.

ARO Elects John R. Markey As Secretary

John R. Markey was elected secretary of the Aro Equipment corporation, Bryan, Ohio, on April 10th. The election was made by the board of directors at its meeting following the annual meeting of shareholders.

Mr. Markey joined Aro in 1939. He was elected a director of the company in 1955 and continues to hold that office. He will also continue to serve as manager of industrial and public relations.

The company manufactures industrial air tools; lubricating equipment for automotive, industry and farm uses; and aircraft products.

Nopco Promotes Dr. R. Christian and Charles H. Lighthipe

Harold A. Swanson, vice president of Nopco Chemical company, has announced the appointments of Charles Lighthipe to the post of technical director of the company's industrial laboratories and Dr. Ramsey Christian to the position of director of the industrial development laboratories, at Harrison, N.J.

Dr. Bernard M. Sturgis, director of the Du Pont company's petroleum laboratory, has been named secretary of the division of petroleum chemistry of the American Chemical Society. He succeeds W. G. Lovell of the Ethyl corporation, who has held the post for several years.

A native of Butler, Indiana, Dr. Sturgis was graduated from DePauw University and obtained his Ph.D. in chemistry from the Massachusetts Institute of Technology. He joined the Du Pont company in 1936 as a research chemist in the rubber chemicals field and ten years later became head of the petroleum chemicals division of the company's Jackson laboratory, where he directed research on tetraethyl lead and petroleum additives.

Dr. Sturgis was assigned to the company's Petroleum Laboratory in 1951 and was named director in February, 1956. More than a score of patents have been granted in his name, and in 1954 he received the Society of Automotive Engineers' Horning Memorial award for the outstanding technical paper on engines and fuels presented that year.

Johnson Named Manager Of Shell's New Products Application Office In Chicago

C. R. Johnson has been named

McGEAN 30% LEAD NAPHTHENATE ADDITIVE

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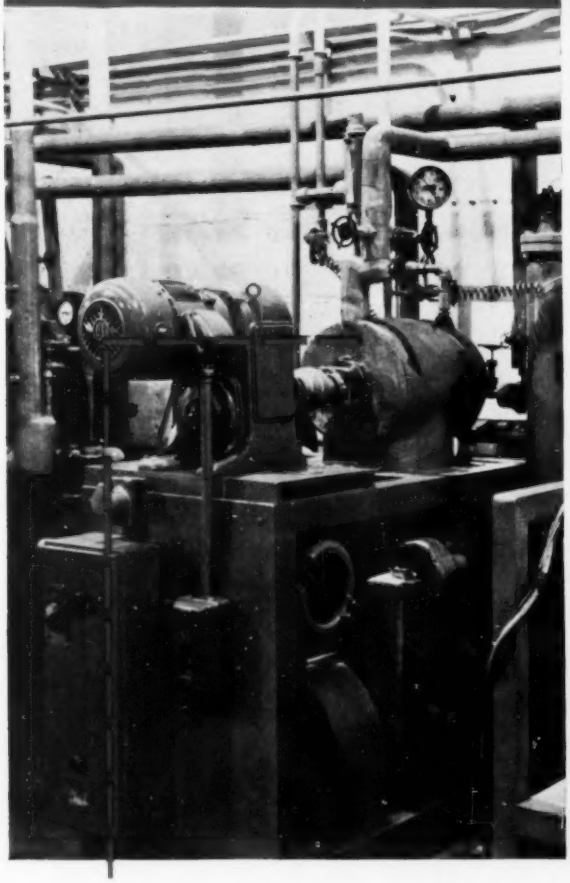
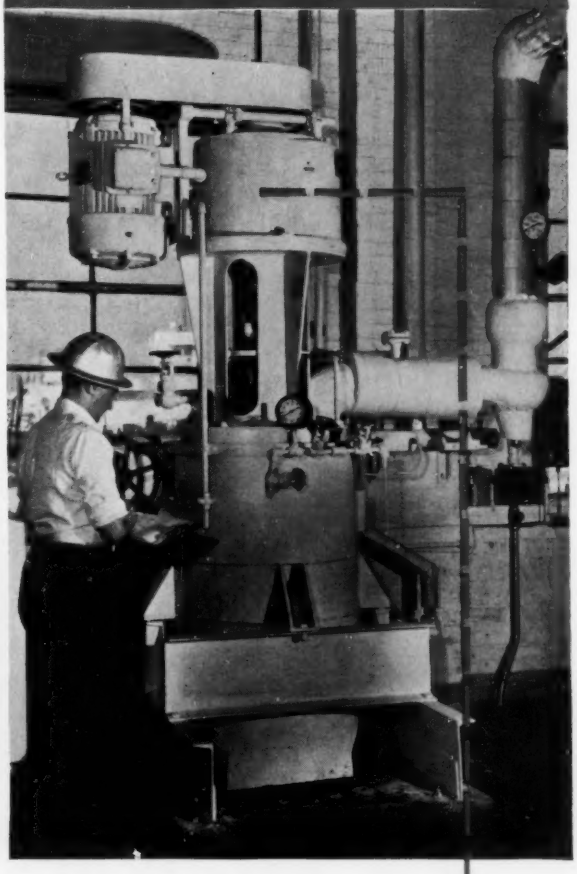


VOTATOR UNIT IN PRODUCTION ... drive end of a 24" x 120" (60 sq. ft.) unit at the Baltimore Refinery of Esso Standard Oil Company.



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manager of Shell Oil company's new products application department office, to be opened in Chicago about July 1. He is now a special engineer in the head office products application department, New York.

According to Shell, the new Chicago office has been established in order to improve service for the firm's midwest marketing divisions.

G. L. Stetson, manager of products application at Shell's Wood River, Ill., refinery, will become assistant to the head office products application manager. Stetson will remain at Wood River to coordinate products application activities with the Wood River research laboratory.

Johnson was born in Claremont, Calif. He received a B.S. in engineering from the University of California before joining Shell in 1934 as an inspector at the Martinez, Calif., refinery. He has served in various manufacturing positions at Dominguez, San Francisco, Torrance, and New York. He was named to his present position in 1954.

Mr. Stetson is a native of Lake Mills, Wis., and a graduate of the University of Wisconsin with BS and MS degrees in mechanical engineering. He joined Shell in 1933 as a tester in the Wood River research laboratory. He has served in manufacturing and marketing positions at Wood River, St. Louis, and New York. He was named to his present position in 1950.

Herbert F. Fagot Joins Vulcan Containers' Chicago Sales Force

Appointment of Herbert F. Fagot to the Chicago sales staff has been announced by L. M. Ferguson, vice-president in charge of sales for Vulcan Containers, Inc., Bellwood, Illinois, manufacturers of new steel pails, drums and tin cans. Mr. Fagot is a graduate of Bradley university, member of Sigma Chi fraternity and a veteran of the U. S. Army Air corps.

Mr. Fagot's appointment is part of Vulcan's expansion program that has included the manufacturing of new full open head grease drums, open and tight head 15 gal. oil drums and open and tight head 55-gallon drums, all available with protective interior linings, pouring spouts and decorated to your requirements.

He will sell Vulcan's full line of steel containers, which range in size from 1 thru 58 gallon capacity, for such basic users as chemicals, paints, adhesives, food and petroleum products industries.

Mr. Fagot formerly was with the Products division of U. S. Steel corporation as a container salesman.

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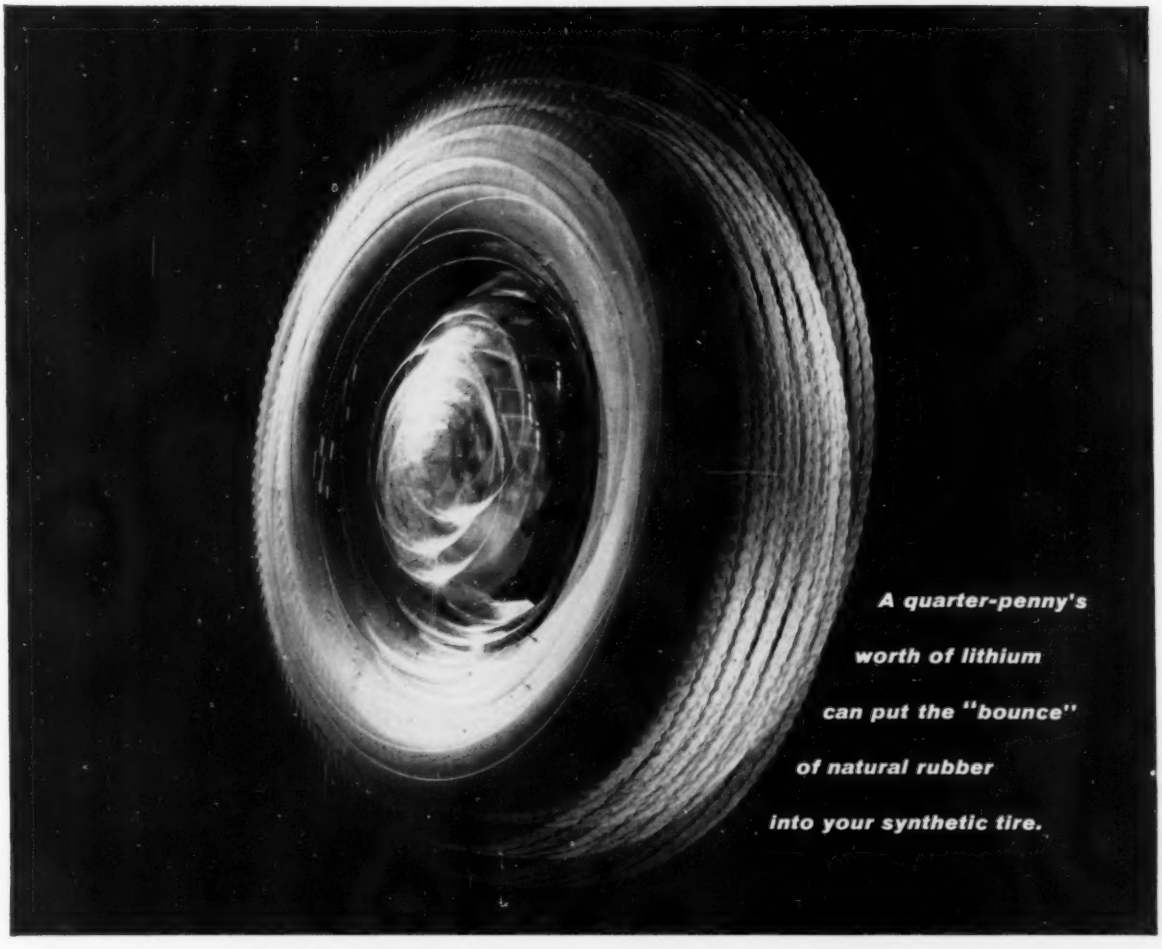

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The fastest way for you to find out what lithium might add to your products—*at so little cost*—is to write for a sample of the lithium compound you are interested in. Be sure to ask for Foote's data folder entitled "The Chemical and Physical Properties of Lithium Compounds." For specific information on the application of lithium to your products, write Technical Literature Dept., Foote Mineral Company, 402 Eighteen W. Chelten Bldg., Phila. 44, Pa.

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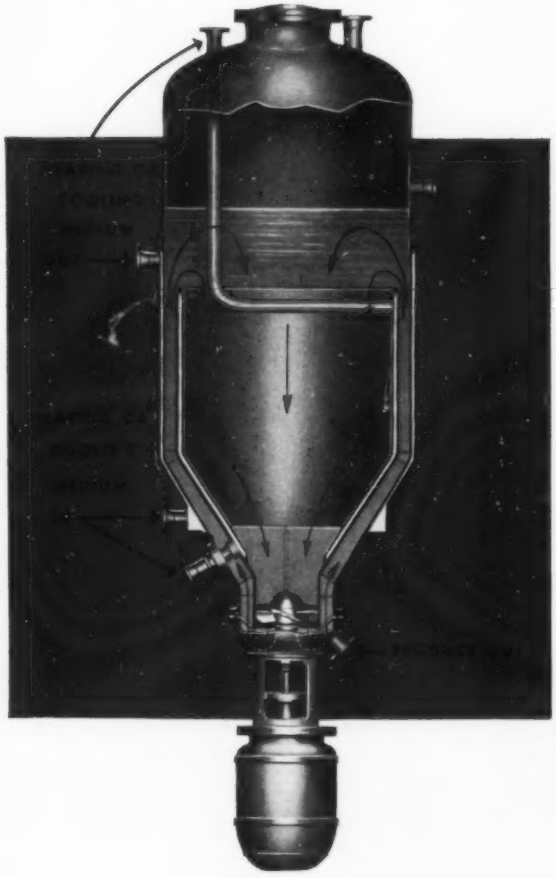

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